Harris Broadcast

TECHNICAL MANUAL

Maxiva™

ULX Transmitter Series

This document covers the following modulations:
Analog
ATSC/MH
CMMB
CTTB
DVB-T/H
DVB-T2
ISDB-T/H

Revision D
888-2628-300
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Deliver the moment.

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Manual Revision History

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Rev B	4/12/2012	61440	Removed references to Ucartherm and replaced with references to Dowtherm SR-1
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Rev D	11/6/2013	63205	Section-2 Doc Pkg References Updated, New Format

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NOTE: For all service and parts correspondence, please provide the sales order number, as well as the serial number for the transmitter or part in question. Record those numbers here:

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WARNING:
THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY WARNINGS, INSTRUCTIONS AND REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. Harris Broadcast shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks. During installation and operation of this equipment, local building codes and fire protection standards must be observed.

The following National Fire Protection Association (NFPA) standards are recommended as reference:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING:
ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING:
IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

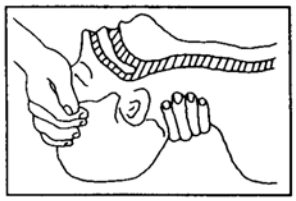
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

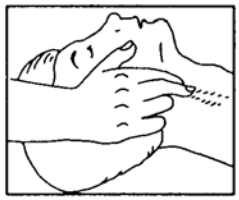
(A) AIRWAY

IF UNCONSCIOUS,
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

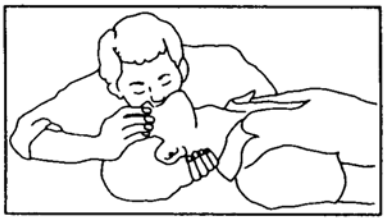
CHECK
CAROTID PULSE



IF PULSE ABSENT,
BEGIN ARTIFICIAL
CIRCULATION

(B) BREATHING

IF NOT BREATHING,
BEGIN ARTIFICIAL BREATHING



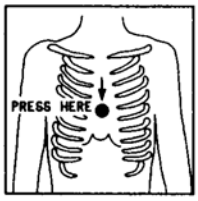
TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES



APPROX. RATE OF COMPRESSIONS --80 PER MINUTE
- ONE RESCUER
- 15 COMPRESSIONS
- 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE
- TWO RESCUERS
- 5 COMPRESSIONS
- 1 BREATH

NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

A. KEEP THEM WARM
B. KEEP THEM AS QUIET AS POSSIBLE
C. LOOSEN THEIR CLOTHING
D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is a brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and there by prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin
    a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
    b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
    c. Treat victim for shock as required.
    d. Arrange transportation to a hospital as quickly as possible.
    e. If arms or legs are affected keep them elevated.

NOTE:
If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)
    a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
    b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
    c. Apply clean dry dressing if necessary.
    d. Treat victim for shock as required.
    e. Arrange transportation to a hospital as quickly as possible.
    f. If arms or legs are affected keep them elevated.

REFERENCE:
ILLINOIS HEART ASSOCIATION
AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

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Section-1 Introduction 1

1.1 Purpose of This Manual

This technical manual contains the information pertaining to the Maxiva ULX Series, solid-state, UHF, TV transmitter. The various sections of this technical manual provide the following types of information.

- **Section 1**, Introduction, provides general manual layout, photos, equipment description, block diagram and general specifications.
- **Section 2**, Installation, provides physical and electrical installation procedures for the transmitter, cooling, RF systems, and basic remote control connections.
- **Section 3**, Operation, provides operational and navigation information for the graphical user interface(GUI) as well as identification and functions of controls and indicators.
- **Section 4**, Theory of Operation, provides detailed theory of operation for the transmitter and sub-assemblies.
- **Section 5**, Maintenance and Alignments, provides preventative and corrective maintenance information and field alignment procedures.
- **Section 6**, Diagnostics, provides detailed fault information and diagnostic procedures to the board level.
- **Section 7**, Parts List, provides a parts list for the overall transmitter as well as individual modules.

1.2 General Description

This section contains a general description of the Maxiva ULX Series television transmitters. Included in this section will be descriptions of the control system, power amplifier, block diagrams and system specifications.

1.2.1 Maxiva ULX Models

Table 1-1 Maxiva Transmitter Models

Analog Models	ATSC Models	COFDM Models	Cabinets	PA Modules
ULX3200AN	ULX1600AT	ULX1100**	1	2
ULX5000AN	ULX2400AT	ULX1700**	1	3
ULX6800AN	ULX3200AT	ULX2300**	1	4
ULX10000AN	ULX4700AT	ULX3400**	1	6
ULX13000AN	ULX6300AT	ULX4400**	1	8
ULX16500AN	ULX7600AT	ULX5500**	1	10
ULX20000AN	ULX9200AT	ULX6500**	1	12
ULX25000AN	ULX12300AT	ULX8700**	1	16
ULX30000AN	ULX13400AT	ULX9500**	2	18(12+6)
ULX40000AN	ULX17800AT	ULX12600**	2	24(12+12)
ULX50000AN	ULX24600AT	ULX17400**	2	32(16+16)
ULX60000AN	ULX25800AT	ULX18900**	3	36(12+12+12)
ULX75000AN	ULX36900AT	ULX26100**	3	48(16+16+16)

NOTES: 1. AN power levels given in peak sync power at the bandpass filter output.
2. ATSC & COFDM power levels given in average power before the bandpass filter.
3. COFDM ** denote modulation types. Modulation types include: DV=DVB-T/H, T2=DVB-T2, IS=ISDB-T/H, CM=CMMB &CT=CTTB.

WARNING: Disconnect primary power prior to servicing.
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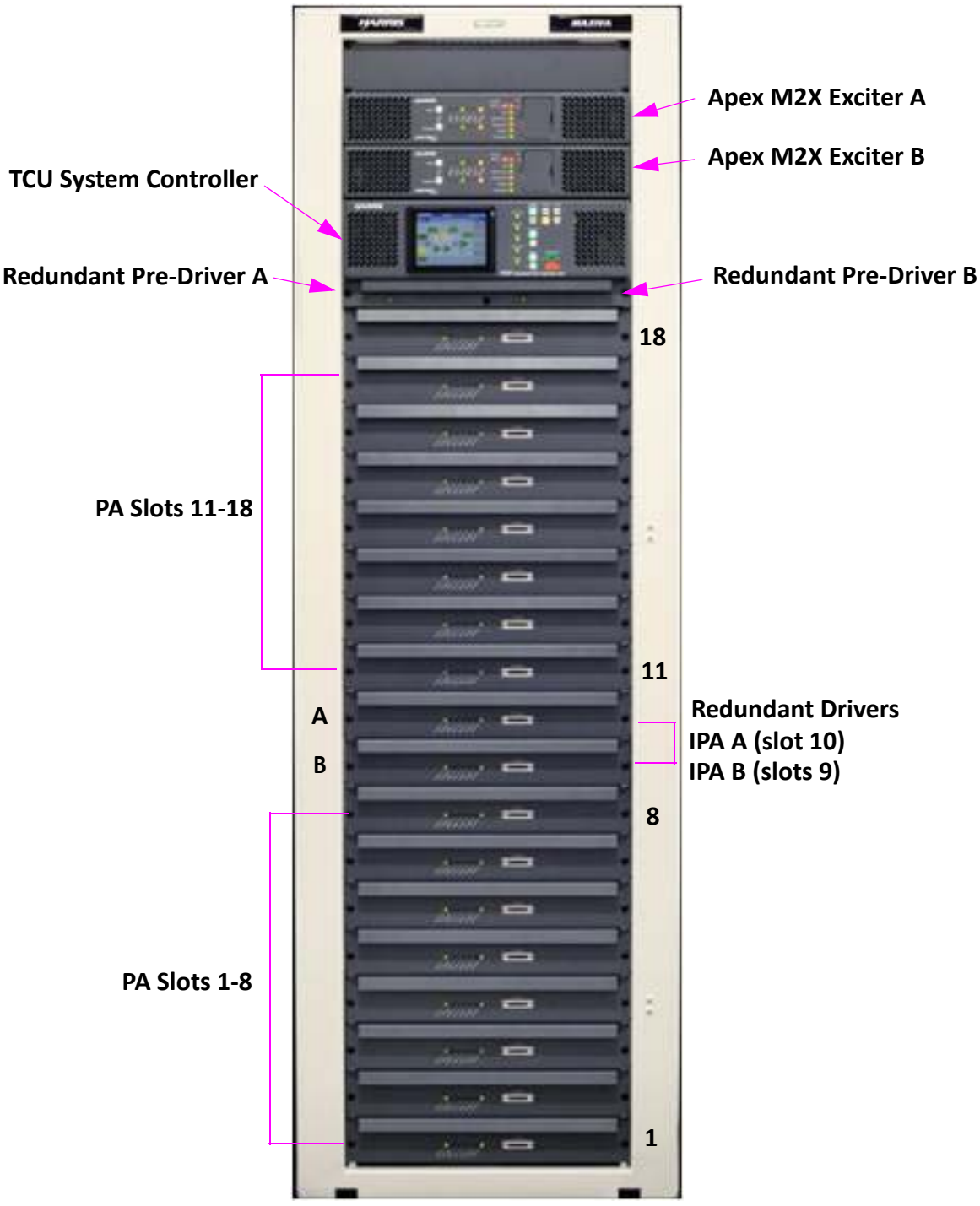

Figure 1-1 ULX Cabinet Front View

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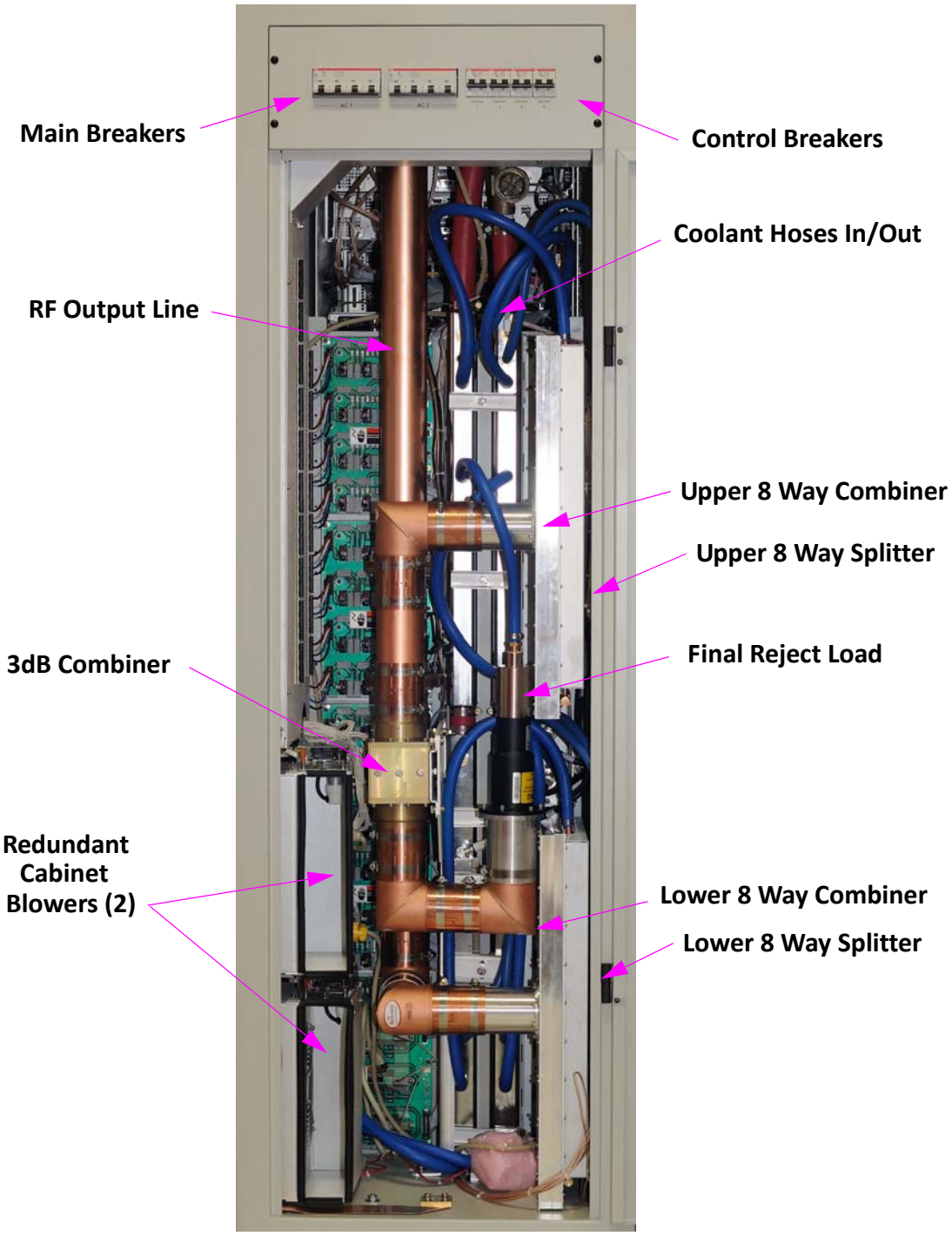

Figure 1-2 ULX Cabinet Rear View

WARNING: Disconnect primary power prior to servicing.
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Table 1-2 Maxiva ULX Power Output

NUMBER CABINETS	NUMBER PA MODULES	POWER OUTPUT (W)							
		PRE-FILTER							POST-FILTER
		ATSC		COFDM				ANALOG	ANALOG
		470-698 MHz	>698 MHz	470-494 MHz	495-630 MHz	631-670 MHz	>670 MHz		
1	2	2,000	1,700	1,200	1,200	1,200	1,100	3,600	3,200
1	3	3,000	2,600	1,800	1,900	1,800	1,700	5,200	5,000
1	4	4,000	3,400	2,400	2,500	2,400	2,300	7,100	6,800
1	6	6,000	5,200	3,600	3,800	3,600	3,400	10,500	10,000
1	8	8,000	6,900	4,800	5,000	4,800	4,400	13,800	13,000
1	10	9,600	8,300	5,700	6,100	5,700	5,500	17,000	16,500
1	12	11,500	10,000	6,900	7,300	6,900	6,500	20.900	20,000
1	16	15,400	13,300	9,200	9,700	9,200	8,700	26,200	25,000
2	18	16,900	14,700	10,400	11,000	10,400	9,800	31,400	30,000
2	24	22,200	19,300	13,300	14,100	13,300	12,600	41,400	40,000
2	32	29,800	25,700	17,800	18,700	17,800	16,800	51,800	50,000
3	36	33,300	29,000	20,000	21,200	20,000	18,800	62,100	60,000
3	48	44,600	38,500	26,700	28,100	26,700	25,200	77,600	75,000

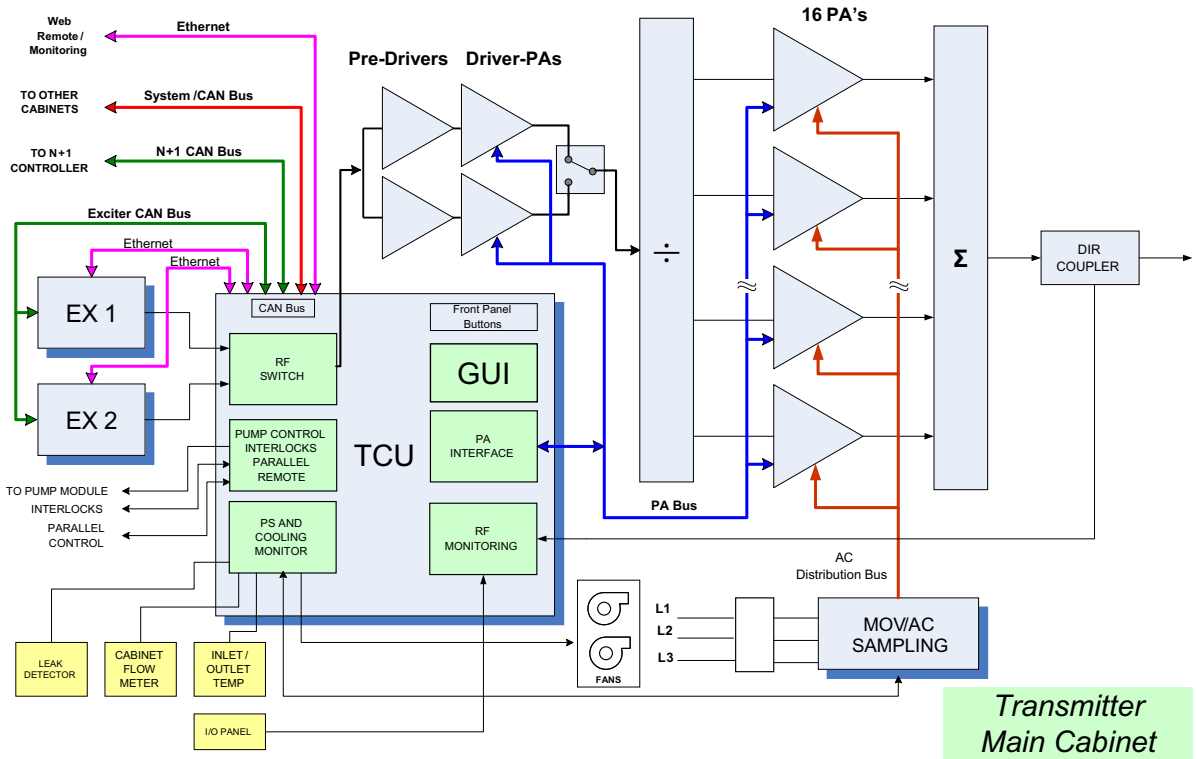

Figure 1-3 Maxiva ULX Cabinet Block Diagram

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1.2.2 System Block Diagram

Figure 1-3 contains a system block diagram showing the basic signal flow and configuration for a single cabinet Maxiva transmitter. The block diagram shows the single cabinet, liquid cooled system with two pre-amp modules, two driver modules and sixteen PA modules. Note that the predriver and driver modules are redundant.

1.2.3 Transmitter Control System

The Maxiva transmitter uses a simplified control system that minimizes the number of microprocessors. Each transmitter sub-system is responsible for its own monitoring and protection and simply reports back to the TCU (transmitter control unit) for display on the GUI (Graphical User Interface) or to a remote interface. In multi-cabinet systems the TCU in cabinet 1 functions as the main controller while the TCU in each amplifier cabinet acts as a slave controller. The cabinet one TCU contains the GUI display for the transmitter. Additional PA cabinets do not contain GUI screens.

The *system bus* originates in MCM (master controller module) inside the cabinet one TCU and goes to the TCU located in each amplifier cabinet. The system bus is used to transfer telemetry information between TCUs.

The *cabinet bus* is similar to the *system bus* but it connects the cabinet TCU (MCM card) to all of the nodes inside each individual cabinet. If *system bus* communications with the master TCU (in cabinet one) are interrupted the *cabinet bus* allows each cabinet to operate independently.

The heart of the control system is the TCU which is responsible for control, monitoring and protection. The TCU contains the MCM (master controller module) which controls all critical transmitter functions and the PCM (processor control module) which provides enhanced monitoring and control, exciter and cabinet data collection, fault logs and web remote connectivity. In addition to the MCM and PCM the Maxiva main TCU contains six modular cards for the following sub-systems:

- PA Interface - Provides interface between TCU, IPA (driver) and PA backplane boards. The interface features forty digital outputs/inputs and twenty-four analog outputs and inputs. A fully populated cabinet will require two PA interface cards, one card per eight PA modules. The PA interface card sends the ON/OFF commands to the PA modules and receives fault information and status from them.
- RF Detector/Pump Control/ Interlocks - Consists of a main board and a daughter card. It features seven RMS detectors with adjustable trip points (via EPOTS). It has pump control and interlocks on one D25 pin connector and, for analog versions, interfaces to an optional analog downcoverter board via another D25 connector.
- Customer I/O - Provides parallel remote control, status and meter outputs. Connector A has all inputs and connector B has all outputs.
- Exciter Switch - Contains PWB (printed wiring board) relay, two RMS detectors with adjustable trips (via EPOTs...*electronic potentiometer*) for power monitoring and a control/status interface for exciters A and B.
- PS Monitor - Monitors AC lines for phase imbalance and high or low voltage, coolant inlet/outlet temperature, coolant flow, leaks, combiner temperature and cabinet fans.

TCU's also contain the following components:

- Base-Plane - provides a common bus for custom plug-in cards
- Power Supply Modules - two redundant internal power supply modules.
- Standard Master Control Module (MCM) - FPGA based controller used for all critical transmitter control functions.
- LED's - standard front LED mimic display panel.
- Processor Control Module (PCM) - ARM based micro module running embedded Linux OS. It provides a touch screen for enhanced monitoring and control, exciter and multi-cabinet data collection, fault logs and web remote connectivity.
- Graphical User Interface (GUI) front panel PC - 5.25" color 1/4 VGA touch screen that is present only in the main TCU (cabinet one in multi cabinet systems).

1.2.4 Transmitter RF Power Control

The PA modules operate without gain or level adjustment. The transmitter RF power control is done via the phase and gain board located in the predriver modules. The predriver output is directly controlled by the TCU in "Auto Power Control Mode".

Each cabinet can also be placed in the "Manual Power Control Mode". In this mode the automatic level control is disabled.

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1.2.4.1 Graphical User Interface

The TCU front panel (in PA cabinet one on multi-cabinet transmitters) contains the graphical user interface which is a 5.25", color, 1/4 VGA, LCD, touch screen, panel PC, display. The touchscreen display uses software buttons to monitor and control the transmitter. A series of front panel pushbuttons provide immediate access to the most important commands and status information.

TCU's in additional PA cabinets will not be equipped with GUI screens.

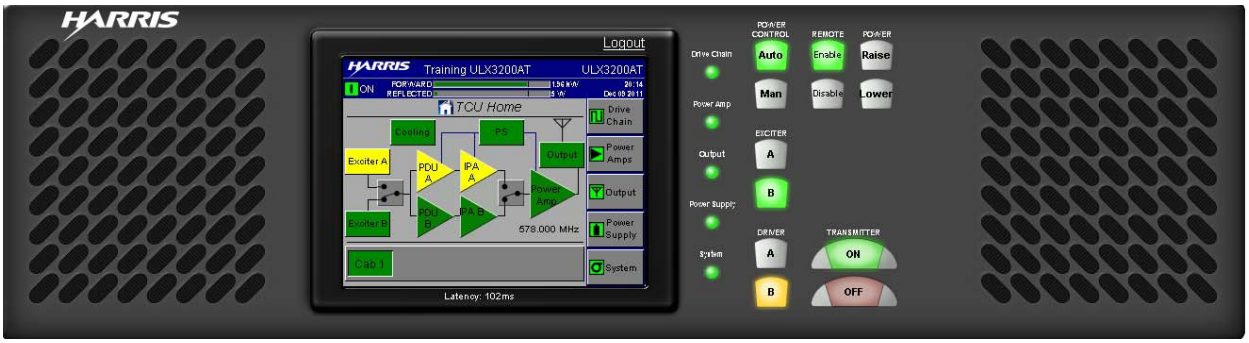

Figure 1-4 TCU Front Control Panel

1.2.5 Control System Communications

The control system uses a serial communications system called a CAN bus. CAN stands for Controller Area Network. The CAN bus is a closed loop serial network controlled by the main TCU. The CAN bus connects the main TCU with TCU's in other cabinets. Each TCU board connected to the CAN bus is considered a node and therefore has a specific address. This allows the master TCU to use the system bus to gather information from all parts of the transmitter and display it on the GUI. One big advantage of the CAN bus is that it requires only 2 wires of the system control bus ribbon cable, eliminating a large amount of discrete wiring which would otherwise be required.

The system bus ties TCU's in each cabinet together. The cabinet bus is for the most part a duplicate of the system bus but intended to connect nodes within each individual cabinet. The cabinet bus originates in the MCM module within each TCU. The cabinet bus is designed to keep the PA cabinets operating even if the communications with the master cabinet TCU is lost.

1.2.5.1 Software Updates

Software does not need to be loaded into the transmitter unless new components are installed or an update is directed from Harris Broadcast. M2X exciter and TCU PCM (processor control module) & MCM (main controller module) software can be updated via remote web browser connection to an external computer. The transmitter, as shipped from the factory, is preloaded and ready to run.

1.2.5.2 Remote Control

The ULX transmitter has the basic discrete wired parallel remote control with the standard connections for control, status and analog monitoring located on the customer I/O panel on the top of cabinet 1. See section 2.18 for additional parallel remote control details.

Maxiva transmitters include a web enabled remote GUI interface that provides comprehensive remote control and monitoring of data points within the transmitter. It includes an SNMP (simple network management protocol) manager which allows integration with most control systems via the Internet or LAN. The remote web connection is made via an Ethernet port on the customer I/O panel on the top of cabinet one.

1.2.6 PA Module

ULX PA modules utilize LDMOS (laterally diffused metal oxide semi-conductor) amplifiers to produce up to 1880 W analog peak, 800 W average ATSC, or 650 W average COFDM power output (these are approximate values and vary

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with model and frequency). Each module weighs approximately 22 kg and can be removed while the transmitter is running. A single cabinet ULX transmitter can have 2, 3, 4, 6, 8, 10, 12, or 16 PA modules combine to achieve the power levels shown in Table 1-2 page1-4. A simplified block diagram of the PA module is shown in Figure 1-5. The part number for a standard PA module is 971-0040-004 (without RF monitor port) or 971-0040-003 (with RF monitor port).

The amplifier and driver modules do not contain microcontrollers but instead use a CPLD based monitor board in each module to report faults to the TCU and to take self-protective action if needed.

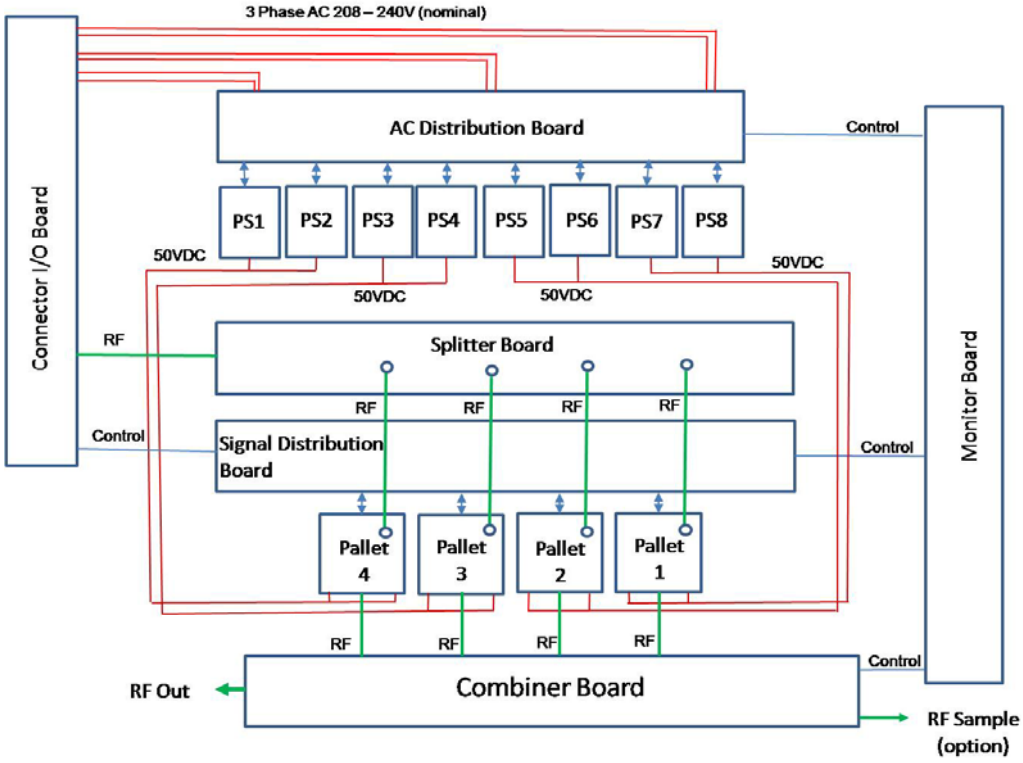

Figure 1-5 PA Module Simplified Block Diagram

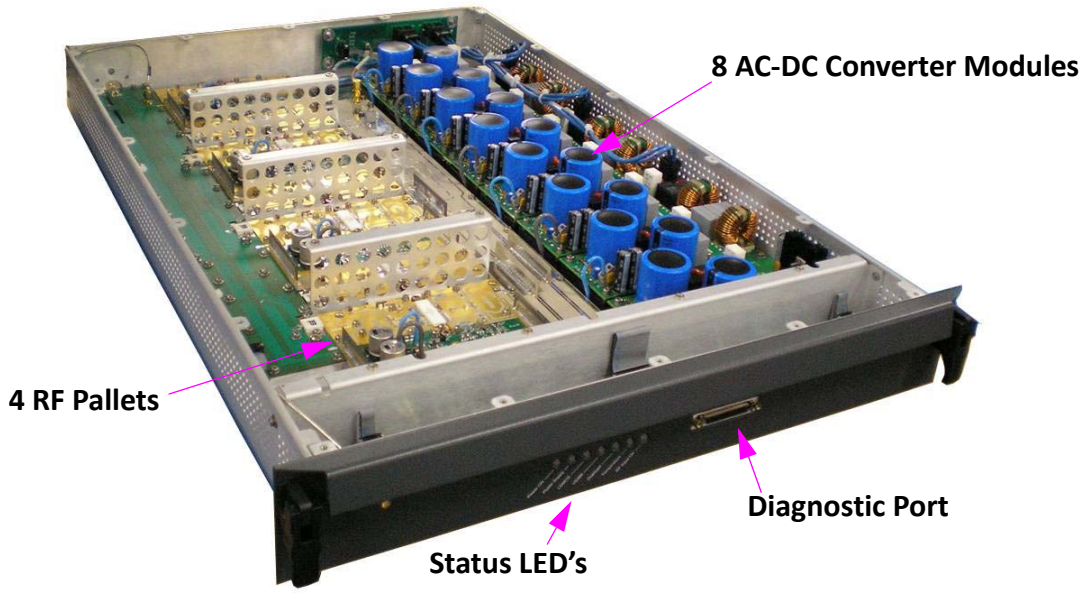

Figure 1-6 ULX PA Module (cover removed)

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The diagnostic port shown in Figure 1-6 allows the operator to connect directly to the module with a handheld PA diagnostic unit and obtain PS voltages, fault status, FWD and REF RF power levels and internal temperatures. The diagnostic port and handheld unit can also be used to reprogram the module CPLD as required. The part number for the handheld diagnostics unit kit is 971-0040-081. The part number for the diagnostics unit technical manual is 888-2765-001.

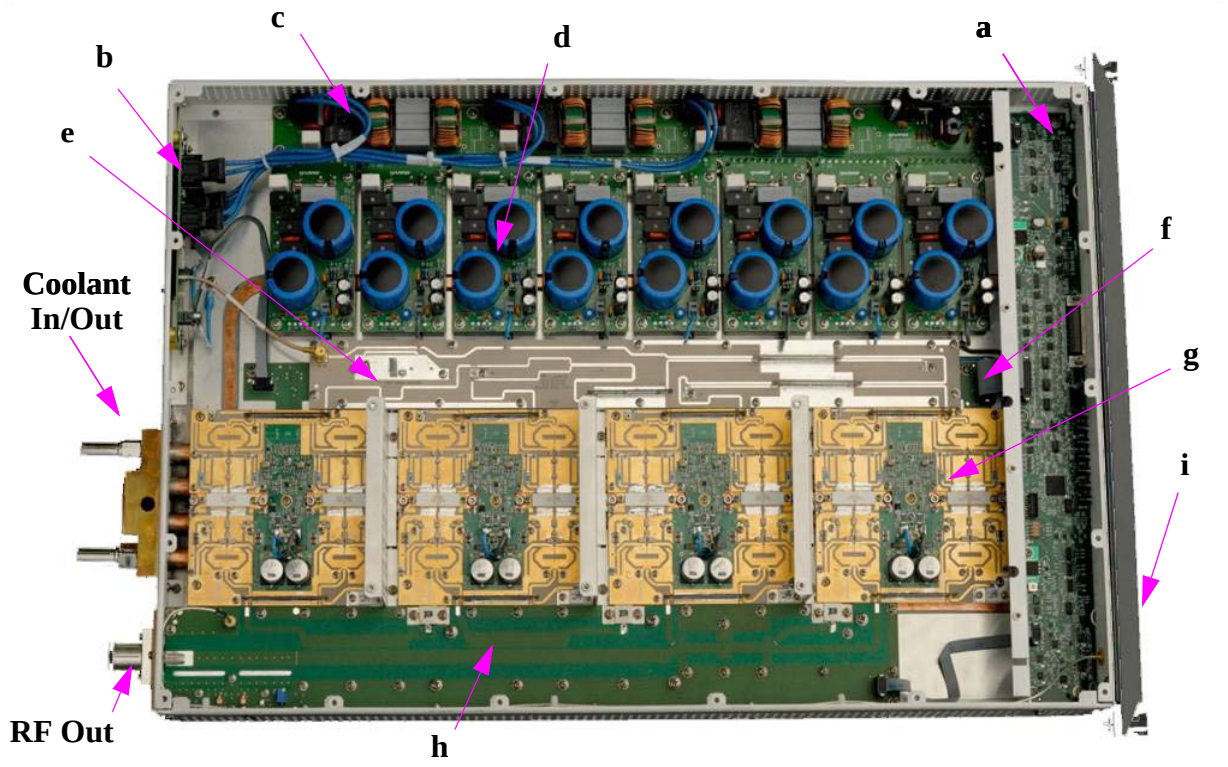

Figure 1-7 ULX PA Module (top view, cover removed)

Each PA module consists of the following components:

a. Monitor Board - Responsible for all monitoring and protection of the module. Reports to the transmitter TCU via the parallel control lines.

b. Connector I/O Board -I/O Connector Board provides interface connections between PA Module and transmitter back plane. The board includes a single hybrid connector on one side and five connectors on the other side. The large hybrid connector interfaces with mating connector on the back plane board. It contains seven AC contacts, twenty-four small signal contacts, and a single RF coaxial connector.

c. AC Distribution Board - The AC distribution board provides three phase AC to the eight power supply boards. It also provides AC line filtering, step-start function and transient protection for the module.

d. Power Supply Boards - The eight AC/DC power supplies provide 44VDC to 50VDC power to each pair of FETs on the four PA pallets. Voltage varies with modulation type and channel.

e. Splitter Board - The splitter board equally divides the RF signal between four power amplifier pallets. The splitter is broadband (covers band IV/V). The splitter board also delivers a detected RF sample to the monitor board to indicate input power level and provide protection from excessive input drive power.

f. Signal Distribution Board - Signal Distribution Board serves to route analog and digital control and monitoring data between four PA module board subassemblies, monitor board, PA pallets, connector I/O board, and 4-way splitter board.

g. LDMOS Amplifier Pallets - There are four single stage amplifier pallets operating in parallel in the PA module.

h. Combiner Board - The board combines the RF outputs of the four amplifier pallets, and delivers the combined signal to the output port. The combiner is broadband (covers band IV/V) and requires no tuning. The combining of the signals is accomplished using hybrid combiners in series. The first stage is a two-way 3dB

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hybrid, the second stage a two-way 4.77dB hybrid, and the 3rd stage is a two-way 6dB hybrid. The use of reject loads in conjunction with the hybrids allows continuous operation of the PA module in the event of a PA pallet failure. The combiner contains forward and reflected directional couplers at its output. Detector circuits deliver the forward and reflected output samples to the monitor board, which indicates the forward power level in dBm and uses the reflected signal for VSWR monitoring and fault protection for the module. Another directional coupler provides an attenuated sample of output RF signal to an optional coaxial port at the front of the PA module (i).

Each PA module is a self-contained transmitter including the power supply with its own internal control, monitoring, and protection. The modules receive basic On/Off, Mute, & Restart commands from the transmitter control system. This means that each module will protect itself without relying on the TCU.

1.2.6.1 Module Control

The primary method for control and monitoring of PA Modules is the individual fifty conductor ribbon cable bus the TCU PA Interface board(s). These busses are called Drive A (for preamp A and IPA A), Drive B (for preamp B and IPA B), and BP 1 through BP 4 (for PA backplanes A5, A6, A8, and A9 respectively). Each module contains a CPLD based monitor board that is responsible for reporting faults back to the TCU and for taking action when the ON/STBY command is issued by the TCU. The cabinet bus connects to each PA and IPA module backplane, it contains the PA_voltage_select line, which sets the DC output voltage of each of the eight AC to DC converters in the IPA and PA modules. The output can be switched between 44, 46, 48, or 50 VDC, depending on the operating frequency.

1.2.7 IPA Modules (modified)

Maxiva cabinets contain two predriver modules and two IPA modules. Each predriver module is dedicated to an IPA module and they switch as a pair. Two types of ULX IPA modules are used.

PA cabinets that use more than eight PA modules use standard PA modules in the IPA slots. These IPA modules can be swapped with any PA module in the cabinet.

PA cabinets that use eight PA modules or less use modified IPA modules. These modified IPA modules can be used only as IPA modules and cannot be installed in PA module slots. part numbers for the modified IPA modules are 971-0040-011 (no RF sample port) or 971-0040-006 (with RF sample port)

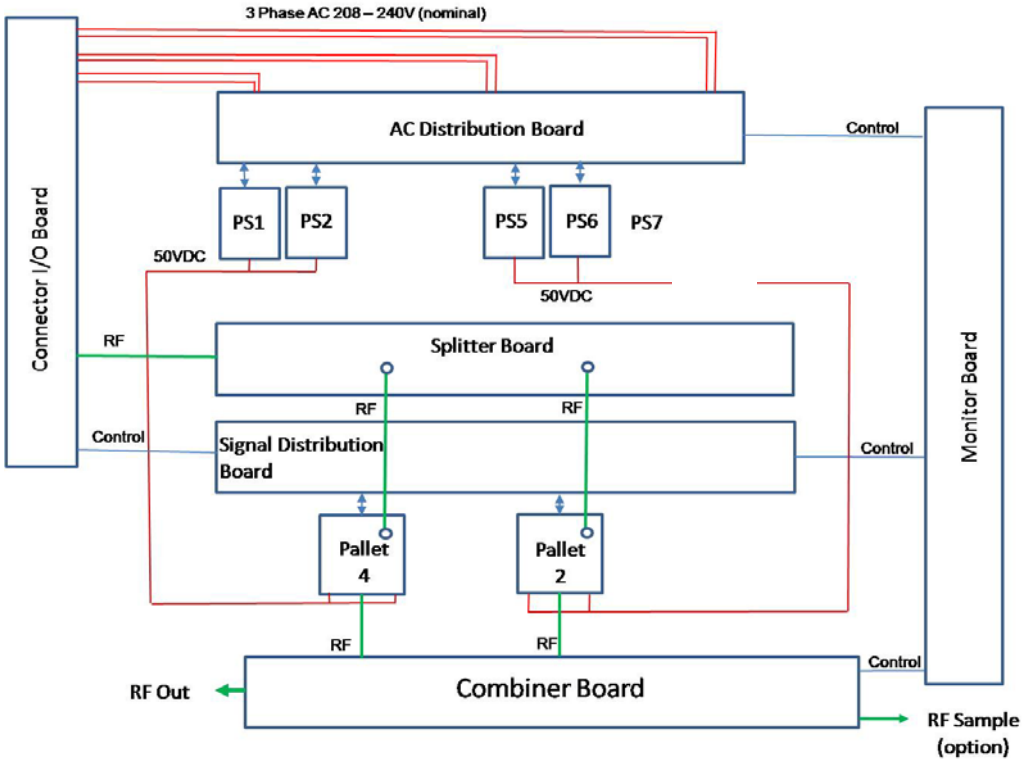

Figure 1-8 IPA Module Simplified Block Diagram

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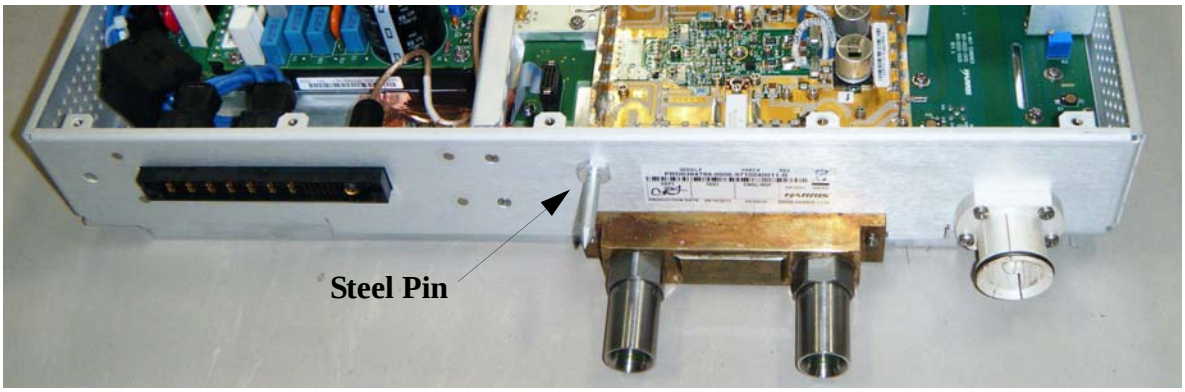

Figure 1-9 Modified IPA Module Rear

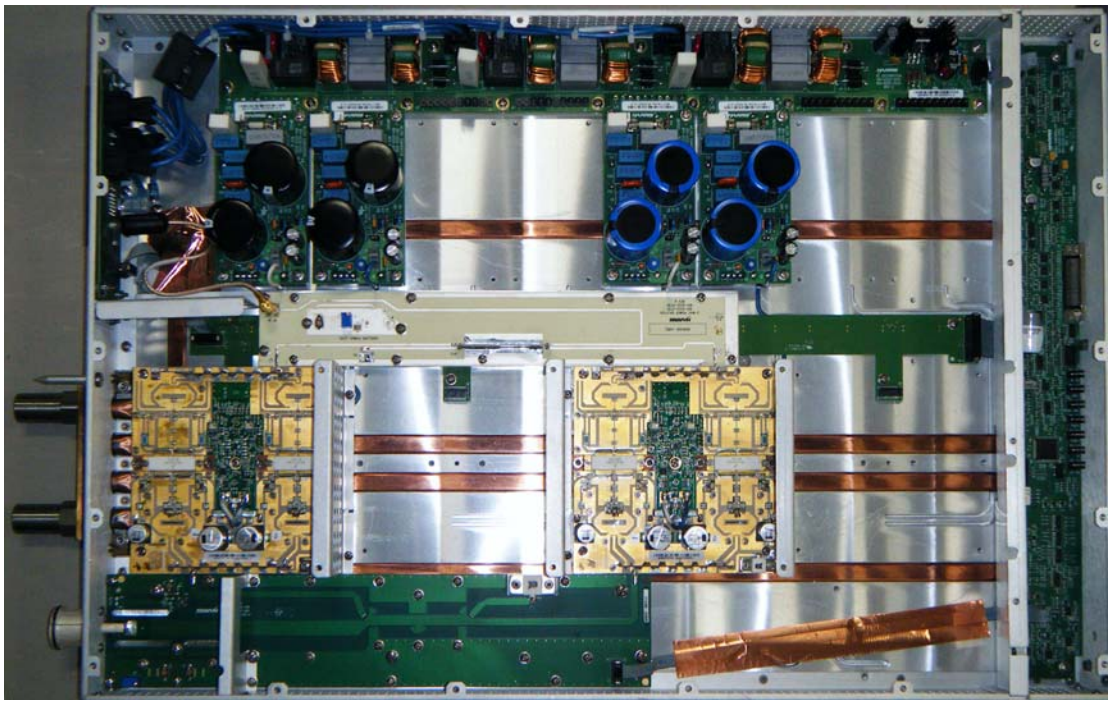

Figure 1-10 Modified IPA Module

1.2.8 Transmitter AC Power

Three phase AC mains must be supplied to the cabinets via circuit breaker CB23 and CB24 on the AC mains input assembly (A15). The transmitter can accept 208-240VAC (Delta or WYE) or 380-415VAC (WYE) by changing jumpers in these areas:

- Terminal boards TB1 and TB2
- IPA (driver) and PA backplane boards

If properly jumpered there will be three phase 208-240V AC inputs supplied to each driver and PA module.

Caution

THREE PHASE 440-480VAC AC MAINS CAN ALSO BE USED BUT ONLY WITH AN EXTERNAL TRANSFORMER WHICH CAN BE ORDERED SEPARATELY FROM HARRIS BROADCAST.

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Transmitters with more than eight PA modules use two MOV (metal oxide varistor) boards. One MOV board is used if there are less than eight PA modules. Two types of MOV boards are used depending on AC mains voltage. Harris Broadcast MOV board part number 971-0040-009 is used for 208-240VAC applications. 971-0040-01 is used for 380-415V WYE systems. The two boards have different jumper configurations.

The 208 to 240VAC is supplied to each PA module's connector I/O board, to AC distribution board, and to eight AC/DC converters (two per pallet). Depending on the operating frequency, the AC/DC converter output can be switched between 44, 46, 48, or 50 VDC, which is applied to the eight FETs (field effect transistors) in the PA module. There are two FETs on each of the four pallets in each module.

The control system in the transmitter is powered by two low voltage power supply (LVPS) modules in the TCU.

1.2.9 Cooling System

The ULX transmitter uses a 50/50 glycol/water, closed loop, cooling system to move the majority of the heat away from the transmitter but also has cabinet flushing fans to remove residual cabinet heat. A simplified block diagram of the liquid cooling system is shown in Figure 1-11. A simplified diagram of the cabinet liquid cooling system is shown in Figure 1-16 on page 1-15. The cooling system includes:

a. Cooling system control panel/pump module(s)
b. Heat exchanger(s)
c. System Air purger located at the highest point in the cooling system.
d. Coolant strainer located in the pump module.
e. Supply and return line hose, valves and fittings.
f. PCI (pump control interface) located in the TCU
g. Transmitter PA module, splitter and combiner cold plates

The cooling system components combine to produce an efficient closed loop, pressurized system. Prior to operation the cooling system must be properly prepared for operation and bled to remove trapped air. Instructions for cooling system preparation can be found in Section 2.7 on page 2-4 of this manual and in the HE Pump Module manual 888-2625-001.

The heat exchanger and pump module operate on either 208-240 VAC, 50/60 Hz or 380-415 VAC 50/60 Hz. The operating voltages and frequencies must be provided at time of order.

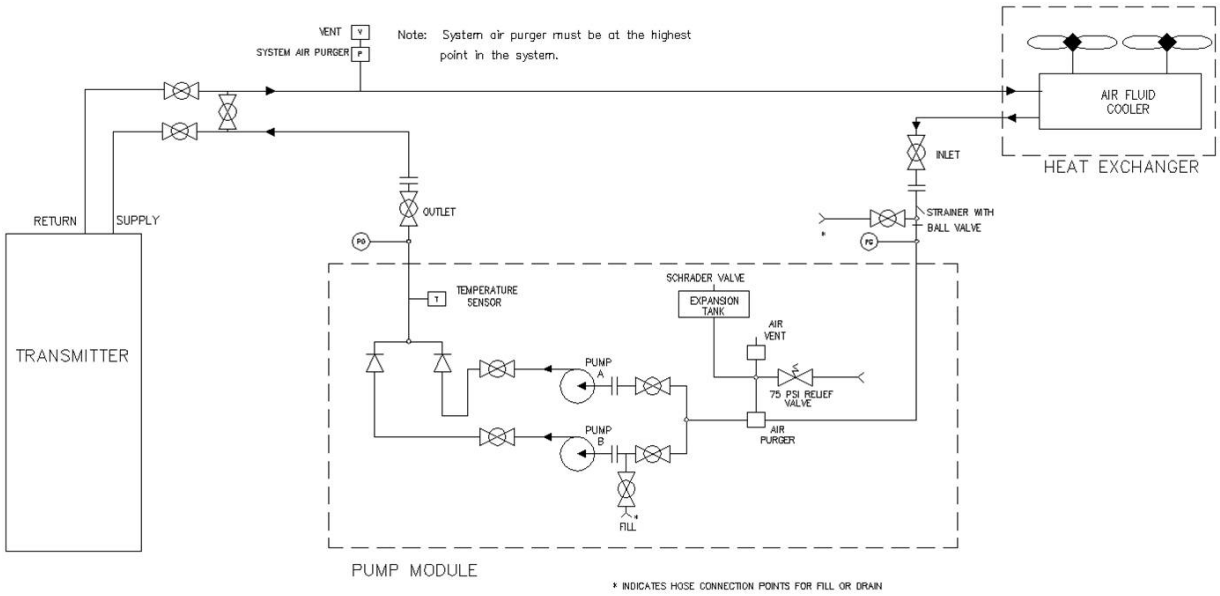

Figure 1-11 Simplified Liquid Cooling System Block Diagram

Caution

SOME MAXIVA ULX SERIES SYSTEMS WILL NOT SUPPORT A WATER COOLED TEST LOAD. IN THOSE CASES AN AIR COOLED LOAD SHOULD BE USED.

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1.2.9.1 Cooling System Control Panel

The cooling system control panel controls the operation of the pump module/heat exchanger, and sends fault and status information to the TCU. The cooling system control cable connects the control panel to customer I/O panel on the top of the transmitter cabinet.

The pump control signals are described in the external wiring diagram 843-5601-705, and in the HE pump module technical manual 888-2625-001.

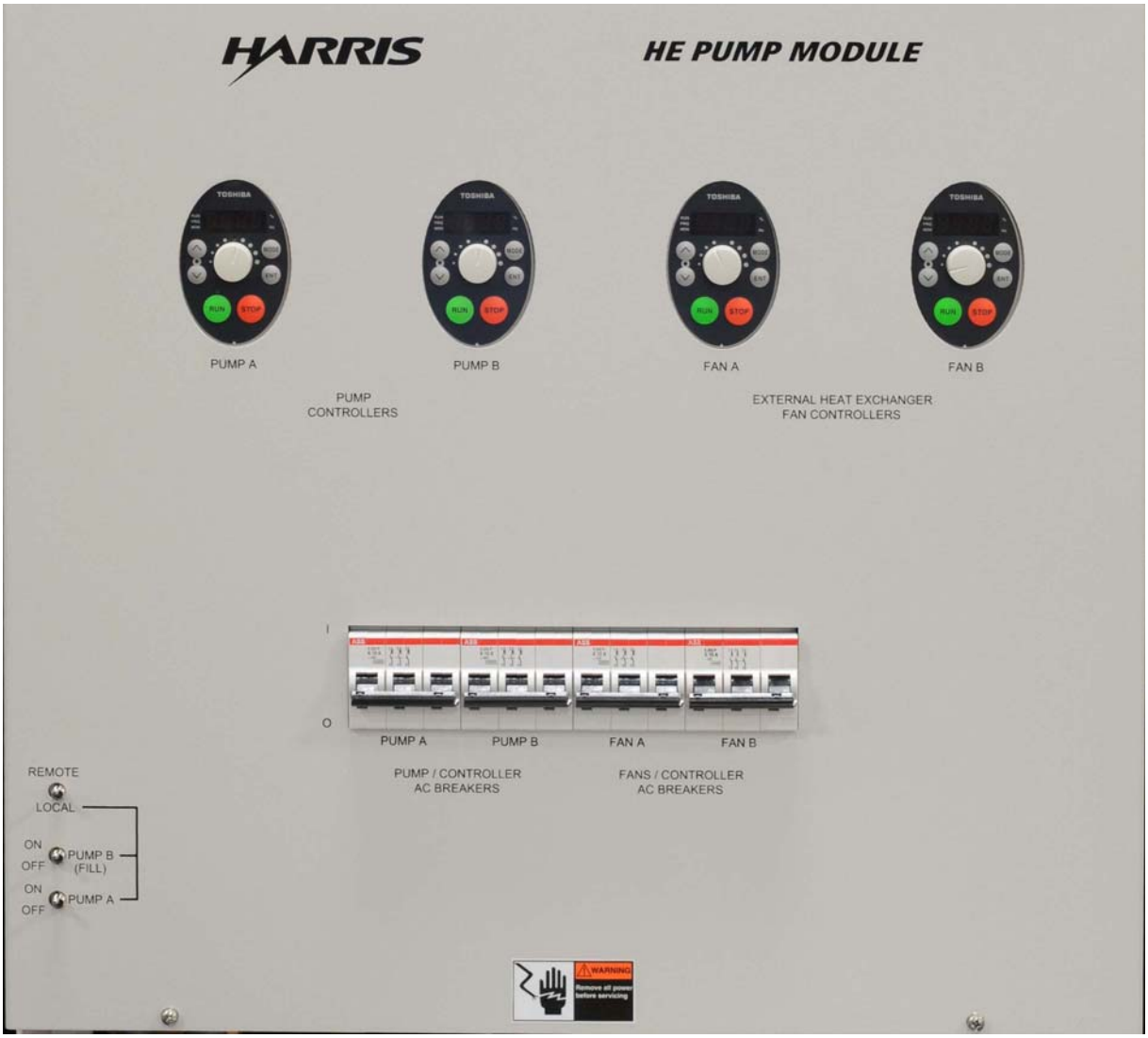

Figure 1-12 HE Cooling Control Panel

1.2.9.2 Pump Module/Heat Exchanger

The control panel/pump module and heat exchanger are separate modular units. The control panel/pump module is self-contained in one rack and includes inverter controllers, an expansion tank, air purger/vent, pressure gauges, pressure relief valve, strainer, and dual pumps operating in main/standby mode. The control panel/pump module is designed for indoor operation (some previous models were suitable for outdoor use). The pump module and control panel should be located near the transmitter if possible. The heat exchanger assembly is designed for outdoor mounting.

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Figure 1-13 HE Pump Module

Figure 1-14 Heat Exchanger-Horizontal Air Flow

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Figure 1-15 Heat Exchanger-Vertical Air Flow

Note

The heat exchanger shown in Figure 1-14 is configured for horizontal air flow .The two fans pull air through the cooling coil/fins (not visible in the photos) and exhaust it parallel with the ground. Figure 1-15 shows a unit configured for vertical air flow. The exhaust in the vertical air flow unit is upward. HE version heat exchangers can be mounted for horizontal or vertical air flow depending on how the legs are attached to the heat exchanger.

1.2.9.2.1 Heat Exchanger Fan Control

Multi-cabinet transmitters will typically have one heat exchanger and control panel/pump module per PA cabinet. The fans are controlled electronically and enabled whenever the pump module is connected to the transmitter with power applied. Fan speeds are controlled by the pump module inverter controls and will increase automatically as coolant temperature increases. Cooling fans do not activate until the coolant temperature rises above 30^{o}C.

1.2.9.2.2 Pump Operation/Control Logic

Pump operation is automatically controlled using two inverter controllers (one per pump). There are two modes of pump operation, "LOCAL" and "REMOTE". The pump module communicates with the transmitter via the pump control interface (PCI) located in the TCU. The pump controller receives and sends signals to the transmitter PCI. With "LOCAL" selected a status signal is sent to the PCI reporting the mode selection.

If transmitter is set to automatic pump switch mode, the loss of flow causes activation of the standby pump. Minimum flow rates vary depending on the number of PA modules and are given in Section 2.15.1 on page 2-29 .

Note

Four pump switches in less than five minutes will cause both pumps to shut down and require operator intervention to restart.

1.2.9.3 PA Module and Combiner Cold Plates

Each PA module has a liquid cooled cold plate which connects to the cooling system with quick release connectors. There are also cold plates inside the combiner(s) and splitter(s) to which all of the internal combiner/splitter reject loads are attached. See Figure 1-16 for cabinet coolant routing and module slot numbering.

Note

Module locations vary depending on model number. See the outline drawing or Table 5-1 on page 5-2 to identify which PA modules slots are used depending on model.

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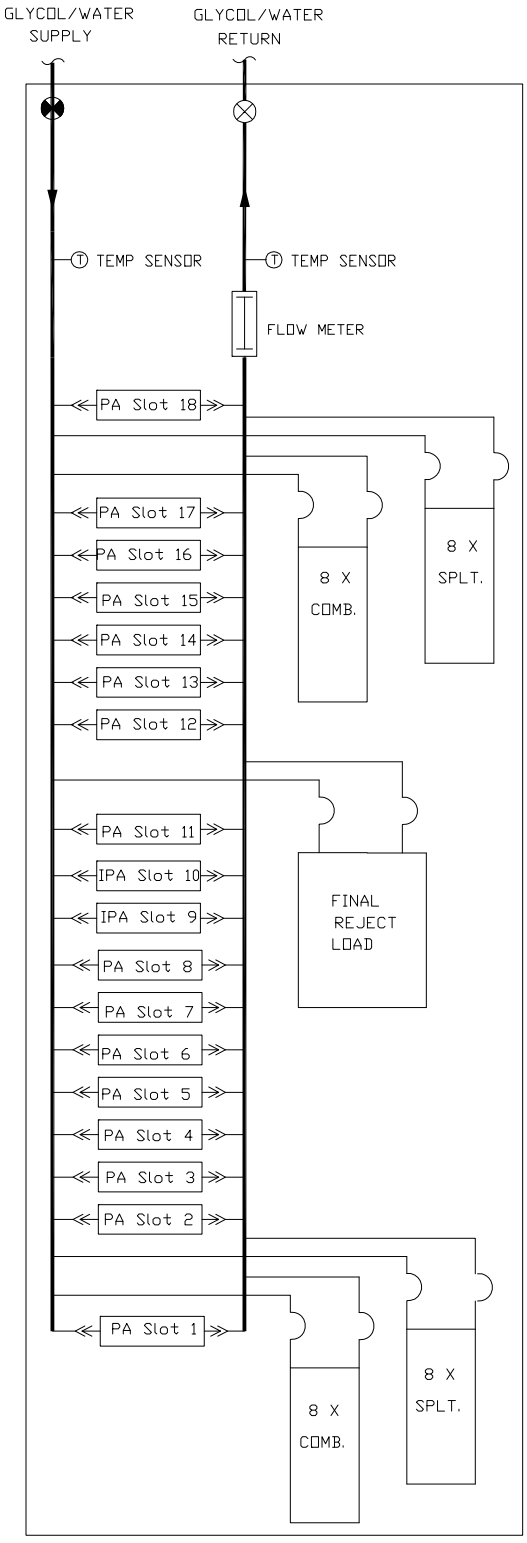

Figure 1-16 ULX Cabinet Liquid Cooling System

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1.2.10 M2X Multimedia Exciter

The Harris Broadcast M2X exciter is used with the Maxiva ULX Series transmitter. This exciter is described in a separate instruction book. An optional standby exciter, and drive chain switcher is available as an option. M2X configuration, editing, diagnostics and monitoring are possible using the front panel on the TCU display, or via web browser. M2X manuals vary with modulation type and are listed in Section 2.2 on page 2-1.

Figure 1-17 M2X Exciter Front

A single exciter drives the Maxiva ULX transmitter. The excellent quality and stability of the UHF signal output maximizes the TV transmitter efficiency, improving performance and helping to reduce operating costs.

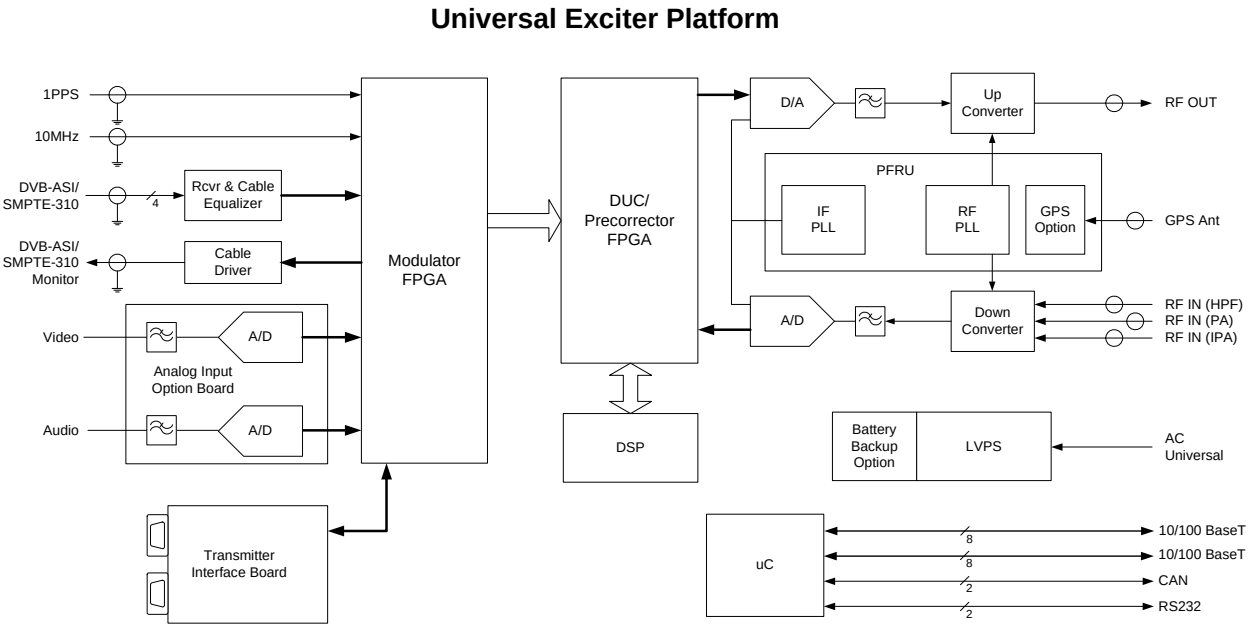

Figure 1-18 M2X Exciter Block Diagram

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1.3 ULX Specifications

SPECIFICATIONS

Specifications are subject to change without notice.

General

Frequency Range	470 to 862 MHz
Channel Bandwidth	6, 7 or 8 MHz
RF Load Impedance	50 ohms, 1.1:1 VSWR over any single TV channel
RF Output Connector	1-5/8 in. (4 mm), 3-1/8 in. (8 mm), 4-1/16 in. (10 mm), EIA (dependent upon power level)

AC Mains

AC Mains Requirement:	
AC Line Voltage	3-phase 50/60 Hz, 380 to 415 V, or 208 to 240 V (specify when ordering)
AC Line Variation	10% to -15%
Power Factor	>0.90

Environmental

Altitude	Up to 13,123 ft (4,000 m) elevation above mean sea level
Ambient Temperature	32º to 113º F (0º to 45º C) at sea level (upper limit derated 35.6º F (2º C) per 984 ft (300 m) elevation AMSL)
Humidity	95%, non-condensing
Cooling Method	Liquid (50% mixture of water and ethylene glycol or propylene glycol)
Acoustic Noise	<65 dBA (measured 3.3 ft (1 m) in front of cabinet, not including pump module)

Analog

Analog Television Systems	CCIR G, I, K, K1, M, N
Color Systems	PAL, NTSC, SECAM
Sound Systems	Monaural, BTSC, IRT, NICAM G
Power Output (vision peak of sync).	2.5 to 60 kW available (higher powers on request)

Analog Video Performance

Video Input	2 inputs, 75 ohms, 0.7 to 1.4 V, 75 ohms, 34 dB return loss
Regulation of Output Power[1]	±3%
Variation of Output Power[2]	±2%
Vision Sideband Response[3].	PAL system G shown (other systems available)
-1.25 MHz and below.	-20 dB or less
-4.43 MHz.	-30 dB or less
-0.75 MHz to -1.25 MHz	0.5 dB or less
-0.5 to +4.5 MHz	0.5 to -0.5 dB
+5.0 MHz	0.5 to -2.5 dB
+5.75 MHz and above	-35 dB or less
Frequency Stability[4]	±150 Hz/month
Differential Gain[5]	3%
Differential Phase[5]	3°
Low Frequency Linearity[6]	10%
Incidental Carrier Phase Modulation[5]	±2°
Signal to Noise Ratio	>60 dB (weighted)
K Factor	2% or less with 2T sin^2 pulse
20T Equivalent Gain and.	3% total baseline distortion
Spurious (Inter-Modulation) and Harmonic Radiation	-60 dB or better
In-Channel Intermodulation Distortion	-60 dB or better

Analog Sound Performance

Frequency Stability	±150 Hz/month
Modulation Capability	±120 kHz peak deviation
Monaural Input	Adjustable 0 to +12 dBm, 600 ohms, balanced, >30 dB return loss
Pre-emphasis	Selectable 75 µS or 50 µS
Frequency Response	±0.5 dB, 40 Hz to 15 kHz
Harmonic Distortion	0.5%, 30 Hz to 15 kHz
FM Noise	60 dB RMS with de-emphasis
AM Noise	50 dB RMS from 30 Hz to 15 kHz
Synchronous AM Noise.	40 dB RMS at 400 Hz with ±25 kHz deviation
IRT Sound	Available on request
NICAM Sound	Available on request

DVB-T, DVB-T2, ISDB-TB, CMMB, FLO™, CTTB

Power Output (Average)	1 to 18 kW models available; measured at output of optional mask filter
Systems	DVB-T, standard ETS 300744, ISDB-TB (Brazil standard)
ASI Inputs	4 type BNC female; 75 ohms acc. to EN 50083-9 (2 main, 2 hierarchical)
Output Power Reduction	0 to -6 dB
Crest Factor Maximum	13 dB
Shoulder Level	<-37 dB (before mask filter)
END	≤0.7 dB
MER	>33 dB
Harmonics (before filter)	<-40 dB
Central Carrier Suppression	>75 dB
Frequency Stability (without external reference)	±150 Hz/month
Frequency Offsets	1 Hz resolution

ATSC

Power Output (average)	1.5 to 24.6 kW models available; measured at output of optional mask filter
System	ATSC A-53, 8-VSB DTV standard
Data Input	19.39 Mb/s
Impedance	75 ohms, unbalanced
Standard	SMPTE 310M
Connector	2 BNC female, isolated
External Precise Frequency Input	10 MHz, sinusoidal
Impedance	50 ohms, unbalanced
Level	0 to 10 dBm
Connector	BNC 50 ohm, female
Signal to Noise (EVM)	27 dB or better (4% or less)
Phase Noise	<104 dBc/Hz @ 20 kHz offset (ATSC A/64)
Pilot Frequency Stability	Less than ±150 Hz/month Less than ±3 Hz with internal or external PFC
Harmonic Radiation and Spurious.	Meets mask requirements specified in FCC 5th and 6th report and order
Sideband Performance	Compliant with FCC radiation mask, when measured at the output of Harris-supplied output filter

Specifications continue on next page.

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Remote Control

Parallel Remote . . . . . DB-37, female

Relay Contacts. . . . . 25 mA @ 24 VDC

Digital Inputs (TTL level) . . . . . Pulse duration ≥100 ms or permanent signal

Ethernet/SNMP (optional) . . . . . RJ-45, twisted pair

Compliance

- RoHS 2002/95/EC
- R&TTE 1999/5/EC
- Safety: EN 60215
- EMC: EN 301-489-1
- FCC Part 73

[1] Variation of peak output power with a change in average picture level from black to white (0% to 100%)

[2] Peak-to-peak variation of peak sync voltage during one field using field test signal per EIA-508

[3] Response specified for transmitter operating into a resistive load of 1.05:1 VSWR

[4] After initial aging of 60 days

[5] Measured using 20% peak-to-peak amplitude swept video modulation with pedestal set at 10%, 50% and 90% APL. All percentages relative to a blanking to white transition

[6] Measured using a 5-step staircase signal. Test signal #3, CCIR REC. #421-3 Derate maximum temperature by 35.6º F (2° C) per 1000 ft (305 m) above mean sea level

Note

Specifications subject to change without notice. Unless otherwise noted specifications apply at the output of the Harris Broadcast supplied mask filter.

End of specifications.

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Section-2 Installation 2

2.1 Introduction

This section includes the information necessary for installation and initial turn on of a Maxiva ULX Series solid state, UHF TV transmitter. Due to the modular nature of the Maxiva, all models have similar installation and testing procedures.

2.2 Documentation

Find and save all documentation.

The top level document package number for each transmitter model is **988-2628-301**.

The transmitter document package includes:

1. **888-2628-300** This technical manual
2. **943-5601-511** Drawing Package with a comprehensive set of schematics for the transmitter system

Exciters technical manual ship with the transmitter. The exciter technical manual varies with modulation type:

1. **888-2624-002** TM, M2X ATSC
2. **888-2624-003** TM, M2X DVB-T/H
3. **888-2624-004** TM, M2X ISDB-T/H
4. **888-2624-005** TM, M2X ATV
5. **888-2624-008** TM, M2X CTTB
6. **888-2624-010** TM, M2X DVB-T2

2.2.1 Installation Drawings

Prior to installation review the documentation to become familiar with the available information. The following drawings will be especially useful during installation.

a. **Outline Drawing** - Shows connections for AC, control, coolant lines and RF output. Also gives cabinet dimensions, required cabinet clearances and a table of basic requirements for all models.
b. **AC Power Flow Diagram** - Shows overall AC wiring and has information on proper wire, fuse and breaker sizes as well as location of disconnects.
c. **RF System Layout** - Shows a typical placement of the transmitter RF components based on minimum required clearances.
d. **External Wiring Diagram** - Shows interconnect wiring between transmitter and all external systems, including AC connections for pump module and heat exchanger.
e. **Wiring Diagram PA Main Cabinet** and **Wiring Diagram Additional PA Cabinet** -Interconnection wiring diagram for all assemblies *inside* the main transmitter cabinet or additional PA cabinets.
f. **Layout, Typical Plumbing** - Shows basic plumbing component locations and connections, flow rate and pressure information as well as simplified cooling diagrams.

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Table 2-1 Maxiva ULX System Drawings

System Drawings	1-Cabinet	2-Cabinet	3-Cabinet
Schematic Document List	943-5601-511	943-5601-511	943-5601-511
Cover Sheet	843-5601-511	843-5601-511	843-5601-511
Outline Drawing	843-5601-279	843-5601-293	843-5601-302
Block Diagram	843-5601-284	843-5601-299	843-5601-299
AC Power Flow	843-5601-583	843-5601-297	843-5601-306
RF System Layout	843-5601-281	843-5601-295	843-5601-304
External Wiring	843-5601-705	843-5601-296	843-5601-305
Wiring Diagram PA Main	843-5601-001	843-5601-001	843-5601-001
Wiring Diagram Additional PA Cabinet	N/A	843-5601-938	843-5601-938
Layout, Typical Plumbing	843-5607-072	843-5607-072	843-5607-072

System Drawing Notes:

1.) RF System Layout 843-5601-288 is for systems containing up to four modules. 843- 5601-281 is for systems containing six to sixteen modules.

2.) The Harris Broadcast HE pump module includes a documentation package (DP) 988-2625-001. The pump module DP includes the HE pump module technical manual 888-2625-001, outline drawing 843-5607-068, and layout drawing 843-5607-072.

2.3 Installation Sequence

Steps in the installation sections are numbered. As each step is completed, the step number can be circled to indicate completion. This provides a quick confidence check at the end of the procedure that no step was skipped. **The primary goal of each step is indicated by bold letters**, with the rest of the paragraph being support information.

Note

In case of discrepancy between connections listed in schematics versus information given in this manual, the wiring information in the schematics should be considered the most reliable. All connections listed in this section should be verified with the schematics before initial turn on.

When performing the installation, after the transmitter cabinet(s) are in place, plan to run the transmitter output transmission lines first, then the liquid cooling system plumbing lines, and finally the electrical conduit runs. If air handling duct work is to be installed, plan all of the RF, plumbing and conduit runs to leave room for the duct work.

The reason for this installation order is that rigid coax runs must be installed with minimum elbows. If the RF runs encounter obstacles such as liquid coolant lines, conduit, and duct work more elbows will be required. The RF lines should have a minimum number of elbows for best performance.

Heavy duty hose can be used instead of rigid copper line, hose is easier to install and can be installed last, as long as large radius turns are used and sharp bends of the hoses are avoided. Hose must be supported more frequently than rigid copper. Good support is required to avoid sagging, because it can trap liquid when the system is drained, stress the hose at the support points, and if the sagging is severe, cause flow restriction due to hose collapse at the support points. Conduit (cable) trays offer the best support for the coolant hose runs.943-5601-308

2.4 Operating Environment

The selection of a proper installation location is essential for equipment longevity and reliability. Do not install the transmitter in places where it may be exposed to mechanical shocks, excessive vibration, dust, water, salty air, or acidic gas.

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Ambient temperature and relative humidity should always range between the following limits at the cabinet installation location:

- Ambient temperature: 0 to +45^{o}C. De-rate 2 degrees C per 300m AMSL.
- Relative humidity: 0 to 95% non-condensing

Note

Failure to follow these installation instructions may void the warranty.

2.5 Transmitter Cabinet Placement

The transmitter cabinet should be placed where it will have approximately 1 meter clearance on each side and in the back. The front of the transmitter should have a clearance of at least 1.5 meters to allow access for removal and installation of the PA modules. There are several drawings included in the drawing package to help plan the cabinet placement:

- Outline Drawing
- RF Equipment Layout
- Liquid Cooling System Layout

STEP 1 **Remove the bolts or straps holding the transmitter to the wooden pallet and carefully slide the cabinet off the pallet.**

STEP 2 **Remove rear door and set aside in a safe place for the rest of the installation process.**

MULTI-CABINET MODELS:

STEP 3 **Place cabinets in position and carefully align**.

ALL MODELS:

STEP 4 **Use levelling shims under transmitter cabinet as required to make sure the transmitter is level and solid (not rocking).**

STEP 5 **Install Drip Tray.** The aluminum drip tray slides under the transmitter just below the rear door panel. The drip tray rests on the floor and is centered underneath the rear of the Maxiva transmitter. It should be checked periodically for presence of coolant.

Note

Do not open the packaging for, or install IPA (driver), or PA modules at this time. These will be installed just before the initial turn on.

2.6 RF System Installation

Refer to the RF System Layout drawing and to installation notes in "2.3 Installation Sequence" on page 2-2.

Refer to the RF Layout and Electrical Installation drawings for Patch Panel connections.

Caution

ALWAYS SHUT THE TRANSMITTER OFF BEFORE REMOVING COAX PATCHES TO PREVENT POSSIBLE DAMAGE TO THE ANCHOR INSULATORS (BULLETS).

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2.7 Cooling System Installation

The major components of the ULX cooling system include the TCU (pump control card), pump module/control panel, heat exchanger, and the interconnecting plumbing. The installation procedures will rely heavily on the following documentation:

a. Electrical installation diagram
b. AC power flow diagram
c. Cooling system electrical diagram
d. Liquid cooling system layout
e. Cooling system outline
f. Appendix B in this manual
g. Pump module technical manual
h. Heat exchanger documentation

2.7.1 Calculation of Cooling System Capacities

Calculation of cooling system capacities is important in order to know how much coolant and distilled water is needed for initial installation and future maintenance. For installation, have enough distilled water on hand for the initial fill up with water, the initial system cleaning, two to four system flushes (to remove the cleaning solution) and the initial fill up with a 50% glycol/water solution. Have enough glycol on hand to perform the initial fill up, and enough glycol and distilled water for a complete system refill in case of a catastrophic leak where all of the system coolant is lost.

The capacities shown in Table 2-2 include all cabinet components such as modules, combiners and splitters. The values do not include the pump module/heat exchanger coolant or the plumbing lines between the transmitter, pump module, and heat exchanger. In multiple cabinet systems each cabinet will have it's own pump module/heat exchanger and associated plumbing.

The capacities shown in Table 2-3 include all components in the pump module/heat exchanger unit. In multiple cabinet systems each cabinet will have it's own pump module/heat exchanger unit and associated plumbing.

To approximate the volume of interconnection plumbing line use Table 2-4 on page 2-5 to determine the corresponding factor needed. Then multiply total of all line lengths by factor to derive tubing volume. Add this volume to the corresponding volumes given in Table 2-2 and Table 2-3 to determine approximate "Total" System Coolant Capacity..

Table 2-2 PA Cabinet Cooling Capacities

PA Modules per Cabinet	Approximate PA Cabinet Capacity (*less plumbing lines*)
2	1.95 gallons (7.38 liters)
3	2.03 gallons (7.68liters)
4	2.10 gallons (7.95 liters)
6	2.24 gallons (8.48 liters)
8	2.39 gallons (9.05 liters)
10	3.21 gallons (12.15 liters)
12	3.35 gallons (12.68 liters)
16	3.64 gallons (13.78 liters)

Table 2-3 Heat Exchanger/Pump Module Capacity

Description	Approximate Capacity
2 Fan Unit	12.98 gallons (49.13 liters)

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Table 2-4 Line length to Capacity Conversion Factors

Nominal Type M Copper Tube or Hose Size	Feet to Gallons	Feet to Liters	Meters to Gallons	Meters to Liters
1-1/4 inch (OD hose)	0.064	0.242	0.210	0.794
1½ inch (ID tube)	0.092	0.348	0.301	1.140
2 inch (ID tube)	0.163	0.618	0.535	2.027
2½ inch (ID tube)	0.255	0.965	0.837	3.167
42 mm (OD tube) 39.6 mm (ID tube)	0.099	0.375	0.325	1.232
54 mm (OD tube) 51.6 mm (ID tube)	0.168	0.637	0.552	2.091
66.7 mm (OD tube) 64.3 mm (ID tube)	0.261	0.990	0.858	3.247

2.7.2 Rigging Heat Exchanger & Pump Module

When the equipment and accessories are received, they should be immediately inspected for shortages and damage. If the equipment has been damaged in shipment or shortages are noted, immediately notify the carrier and file a claim.

The equipment should be kept on the original pallet until ready for final installation. When using lifting belts (straps) ensure that a spreader bar is used and belts do not compress sheet metal or plumbing.

The exact method of handling and setting the heat exchanger and pump module depends on the available equipment, the size of the unit, its final location and other variables. It is the installer's or mover's responsibility to determine the specific method of safely handling each unit. If possible, when the units arrive at the site and are unloaded from the truck, plan to set and secure the heat exchanger in its permanent place on its concrete pad or on the roof. The pump module (with control panel) should immediately be moved to an indoor location.

Caution

ENSURE THE PROPER EQUIPMENT IS AVAILABLE TO SAFELY INSTALL THE UNIT. EXTREME CARE SHOULD BE EXERCISED DURING THE FOLLOWING STEPS TO AVOID EQUIPMENT DAMAGE OR PERSONNEL INJURY.

Note

When feasible the heat exchanger and pump module plumbing can be pressurized to 15 PSI with air or an inert gas (nitrogen), as a leak check prior to rigging and/or final placement.

2.7.3 Placement of Heat Exchanger

The heat exchanger unit is typically installed outdoors. Locate the unit outside of the building, as close as possible to the transmitter to minimize pipe/hose run length and pump requirements. The heat exchanger should be oriented so that access to the electrical connections, fans, and fan motors is convenient.

If mounted outside the building, but not on a roof, make sure a concrete pad is poured and allowed to cure before placing the heat exchanger module in place. Plan to unload the heat exchanger unit directly to its final location.

Allow extra space for concrete in front of, beside and behind the unit to prevent dirt being sucked in by the fans, and to allow space for maintenance and inspection.

When mounting on a roof, install unit such that building columns or load bearing walls offer adequate support. Place unit to allow room for access during installation and maintenance

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Caution

FOR VERTICALLY MOUNTED HEAT EXCHANGERS (EXHAUST AIR PARALLEL TO GROUND ON FAN SIDE) THERE SHOULD BE NO OBSTRUCTION WITHIN TWO METERS OF THE EXHAUST SIDE OR WITHIN ONE METER OF THE INTAKE . HORIZONTALLY MOUNTED HEAT EXCHANGERS (EXHAUST AIR DIRECTED UPWARD) SHOULD HAVE NO OBSTRUCTIONS WITHIN TEN METERS OF OUTPUT EXHAUST.

A method of protection from prevailing, direct wind is recommended on the exhaust side of vertical heat exchanger fans. A blocking partition approximately 4 meters from the exhaust side of the fan is recommended. Blocking incoming wind helps prevent fan start up problems due to backward fan rotation.

The heat exchanger unit must be level before fastening mounting legs to the supporting structure (steel frame for roof location or concrete pad for ground location) .

STEP 1 **Lift the heat exchanger unit and place into position (vertical or horizontally oriented heat exchangers may be encountered).** Observe manufacturer's assembly and lifting recommendations.

STEP 2 **Install the leg channels and brace angles as required**.

STEP 3 Carefully place assembled unit onto concrete pad or support frame.

STEP 4 Level the unit using shims.

STEP 5 Secure the unit to the concrete pad or support frame using anchor bolts.

STEP 6 **Install safety warning labels.** Locate and install according to instructions.

STEP 7 End of Procedure.

2.7.4 Placement of Pump Module

The HE pump module must be installed indoors. An electrical control panel is integrated into the pump module assembly. Some earlier versions of the pump module and control panel were designed for either indoor our outdoor use. The current HE pump module is specifically designed for ***indoor use only.***

The pump module should be positioned near the transmitter so the electrical panel can be readily viewed and is easily accessible.

STEP 1 **Lift the pump module unit and place it in the desired location.**

STEP 2 **Level the pump module with shims as required.**

STEP 3 Secure the pump module unit to prevent movement during operation.

STEP 4 **Install safety warning labels.**

STEP 5 End of procedure.

2.7.5 Plumbing Installation

The system total coolant plumbing circuit length *must* not exceed 40 meters (131 feet) total length including supply and return lines. Vertically, a maximum difference of 8 meters (26 feet) between pump module/heat exchanger and the transmitter is allowable.

Layout the liquid cooling system with as few elbows as possible because excessive elbows or back to back 45 or 90 degree elbows will greatly restrict the coolant flow. If hose is used instead of copper lines, avoid sharp bends of the hoses because that can collapse the hose at the bend and greatly restrict coolant flow. Hoses will require more support than copper lines. If hoses are to be used, lay them in a cable tray if possible, or use padded hose supports a MINIMUM of 1 meter apart.

Any turbulence causing device in the coolant plumbing system can restrict flow and increase the dynamic head pressure of the pump. If two turbulence causing devices are connected back to back, the flow restriction and

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pressure drop across the pair of devices is greatly multiplied over the restriction of individual devices. Turbulence causing devices include, but are not limited to elbows (45 and 90 degree), tees, ball valves, gate valves, globe valves, flow sensors, pipe diameter changes, and etc. To minimize the effects of any turbulence causing device added to the coolant plumbing system, a good rule to follow is to have 10 diameter lengths of straight pipe between turbulence causing devices. This will allow the turbulence to dissipate and the flow to again become uniform. This effect, called "static pressure regain", will cancel out much of the flow restriction and pressure drop caused by the turbulent device.

Note

If any of these restrictions cannot be met, a site-specific modification may be required. Contact your Harris Broadcast representative for modifications.

All fluid piping practices should be in accordance with local codes. Standard installations will use heavy duty hose for connecting the transmitter to the heat exchanger and pump module but copper field piping using type M, hard drawn copper pipe and sweat joints made with soft silver solder is an acceptable alternative.

Note

Piping materials such as steel, galvanized steel, cast iron, brass or plastic should not be used. Do not use any type of galvanic piping or components in the ULX cooling system.

Whenever components made from electrically dissimilar materials are used in a system, use dielectric isolation of the materials to help prevent galvanic corrosion. All threaded pipe connections must be sealed and any flanged connections gasketed; use a sealant or Teflon tape on threaded connections or the glycol/water solution will leak.

Correct sizing of pipe or hose is critical to assure smooth operation and keep operating costs to a minimum. Calculation of total system friction pressure loss determines optimum pipe size. For closed-loop systems, do not include the static head pressure of the system piping, as equal and opposite forces cancel out upward and downward flow. All elbows, tees, valves and system component pressure drops must be considered when determining pipe/hose size. Pump selection at rated flow is based on 150 feet total length. Refer to installation drawings for recommended pipe and hose sizes.

Proper use of valves (gate type, ball type or globe type) is required to allow for isolation of components (bypassing) in the event of maintenance to reduce closed circuit system glycol/water loss. Bypassing of the transmitter cabinets is also desirable to avoid contamination of the transmitter during initial coolant system flushing.

Install components as described in the Liquid Cooling System diagram. Globe or ball valves should be used in the supply side of each cabinet. Globe valves allow for fine adjustment of coolant flow through components. Gate or ball valves should be used on the return line side of cabinets and component.

Caution

COOLANT VALVES SHOULD BE OPENED AND CLOSED SLOWLY TO PREVENT PRESSURE SURGES IN THE COOLING SYSTEM.

The pump module has a 1/2" NPT fill and drain valves (3/4" female garden hose connections). An air purger and automatic air vent (return side) are incorporated into the unit for removal of air bubbles, which are induced in the system during filling. Additional air bubbles will continue to be purged and vented as the system operates at higher temperatures.

The system air purger is typically part of the bypass assembly and is located inside the building, preferably within view of the transmitter, at the highest point of the plumbing installation. The system air purger may be equipped with a sight glass to allow the operator to monitor coolant level and formation of air bubbles that may indicate that the system needs to be charged with additional coolant. Drain valves should be located at all low points in the system to allow the system to be fully drained.

STEP 1 **Install supply and return plumbing**. Carefully locate and solder (copper fittings) or clamp (hoses) drain/vent valves, plugs, meters, elbows, adapters, and fittings, to the transmitter, pump module, heat exchanger, filter, reject and test loads according to the drawings (see " " section for more info). Supply and return hose should be installed without sharp bends. Hose should be supported frequently to avoid excessive movement as pumps turn on and off. Hose should be supported using padded clamps or preferably a cable tray.

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Note

Minimize the use of pipe joint compound, teflon tape and soldering flux. Overuse of these items make the system more difficult to clean.

STEP 2 On long runs of pipe or hose, **slope the run (toward a drain point) at a rate of 1 to 2 inches per 100 feet to facilitate draining or bleeding the system.**

STEP 3 **Install the system (automatic) air purger, shown in Figure 5-29 on page 5-35, it should be installed at the highest point in supply line.** The system air purger should be visible from the transmitter area since it will need to be monitored frequently for cooling fluid level and air bubbles. It is typically installed as part of the bypass assembly.

STEP 4 **Install manual drain valves at each low point in the plumbing system.** These drain valves allow the closed loop system to be thoroughly drained of liquid as required for flushing or draining the system.

Caution

BEFORE ROUTING PLUMBING BE SURE THAT SPACE IS RESERVED FOR ROUTING OF RF TRANSMISSION LINE. IT IS IMPORTANT TO MINIMIZE THE NUMBER OF RF COMPONENTS IN THE SYSTEM AND TO AVOID BACK TO BACK ELBOWS.

Once all pipe, hose and component installation is completed, the system is ready for leak tests.

Caution

ISOLATE THE EXPANSION (PRESSURE) TANK PRIOR TO PRESSURE TESTING BY CLOSING THE BALL VALVE AT THE TANK INPUT. CLOSING THE VALVE PROTECTS THE INTERNAL BLADDER FROM DAMAGE DURING THE INITIAL PRESSURE TESTING.

Caution

DO NOT PRESSURE TEST THE PIPING OR HOSE SYSTEM TO HIGHER THAN 15 PSI.

Caution

DO NOT USE THE SCHRADER VALVE ON THE EXPANSION TANK TO PRESSURIZE THE SYSTEM. THE TANK HAS BEEN PRESSURIZED AT THE FACTORY AND IT SHOULD NOT BE CHANGED.

STEP 5 **If feasible, charge system with 15 PSIG of air and then apply water/soap solution to each joint and look for bubbles.** Repair leaks as required until system holds pressure. Depressurize the system and open the expansion tank ball valve. **Charge the cooling system with pure water using a charge pump or with circulating pump B if an HE pump module is being used.** Charging a system with circulating pump B is outlined in the HE Pump Module Technical Manual 888-2625-001 which ships with the pump module.

Caution

IF THE SYSTEM IS INITIALLY CHARGED WITH PURE WATER DO NOT ALLOW IT TO BE EXPOSED TO TEMPERATURES BELOW FREEZING. FREEZING WATER IN THE COOLING SYSTEM WILL RESULT IN DAMAGE TO THE SYSTEM COMPONENTS.

STEP 6 End of procedure.

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2.7.6 Pump Module/Heat Exchanger Electrical Installation

The electrical installation of the heat exchanger and pump module unit should be in accordance with the National Electrical Code and any local codes and regulations. The incoming AC power is either 208-240V or 380-415V, 3 phase 50/60Hz. Fan and pump motors are three phase.

Warning

DISABLE AND LOCK OUT STATION PRIMARY POWER BEFORE PRIMARY POWER CABLES ARE CONNECTED TO THE EQUIPMENT.

STEP 1 **Install conduit and route AC mains cabling to the pump module and from the pump module control panel to the heat exchanger isolator switches.** Install and wire according to the Harris Broadcast External Wiring diagram and follow local wiring codes.

STEP 2 **Install another conduit and route wiring for status and control lines between the pump module and transmitter cabinet.** Install and wire according to electrical schematic diagram and local wiring codes.

Caution

SMALL SIGNAL (CONTROL/STATUS) WIRES AND AC WIRING SHOULD NEVER BE RUN IN THE SAME CONDUIT.

STEP 3 **Turn OFF the circuit breakers on the pump module control panel and the isolator switches on the heat exchanger unit.** They will be turned ON later in the procedure to check for wiring problems.

STEP 4 **Connect the control and status wires to the cooling control panel with the supplied multi-conductor cable.** These connections are described on the external wiring diagram. These low level signals connect the terminals in the pump module control panel (J3 or J4) to the pump module connector on top of the transmitter cabinet.

Note

The pump module connections are also shown in the HE pump module technical manual 888-2625-001 Table 2-2 on page 2-7.

Note

Condensation can occur in the conduits connecting the heat exchanger (outside) and the transmitter (inside). These conduits should be caulked or sealed after the system is tested and operational. Sealing the conduit prevents warm air inside the building from entering the portion of the conduit that is located outside the building.

STEP 5 **Connect the control and status wires to connector J1 on the customer I/O panel (located at the top of the transmitter) with the supplied multi-conductor cable.** These low level signals connect from terminals inside the pump module control panel (J3 or J4) to J1-1 through J1-12 (see Figure 2-1), on the connector labelled pump module on the customer I/O panel on top of the transmitter.

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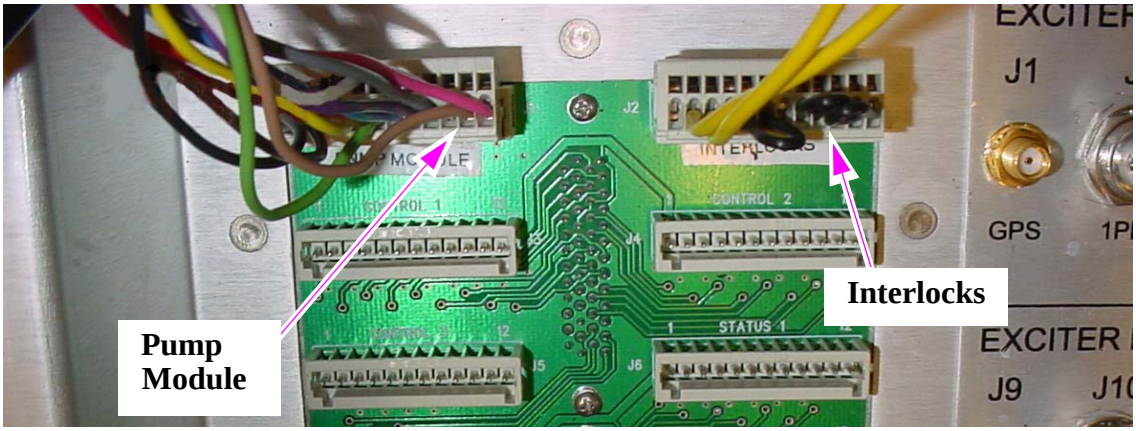

Figure 2-1 Customer I/O Pump Module and Interlock Connector on Transmitter

Caution

SOME MAXIVA ULX TRANSMITTERS WILL NOT SUPPORT A WATER COOLED TEST LOAD USING WATER SUPPLIED BY THE ULX PUMP MODULE. IN THOSE CASES ONLY AIR COOLED TEST LOADS SHOULD BE USED.

2.8 Transmitter AC Connection

Refer to the outline drawing top view for details on AC inputs to top of cabinet.

Note

AC Connections will be similar across all cabinets in multi-cabinet transmitter models. Be sure to verify all connections using the correct schematic drawings.

Warning

DISABLE AND LOCK OUT STATION PRIMARY POWER BEFORE PRIMARY POWER CABLES ARE CONNECTED TO THE EQUIPMENT.

Caution

WHEN CONNECTED TO A 380-415VAC 3 PHASE WYE POWER CONFIGURATION, NEUTRAL CURRENT CAN BE EQUAL TO OR EXCEED PHASE CURRENTS DUE TO SWITCH MODE POWER SUPPLY HARMONICS. ENSURE NEUTRAL CONDUCTOR IS PROPERLY SIZED AND THAT ALL LOCAL REGULATIONS ARE MET.

Note

The Maxiva ULX cabinets can use the following AC Mains configurations assuming the jumpers in the PA module backplanes and in AC distribution panels are properly configured at the factory:

- 208-240VAC, 3 phase Delta or Wye
- 380-415VAC, 3 phase WYE, with neutral wire

Note

If a 440-480VAC, 3 phase Delta AC supply is to be used, a step-down transformer is required.

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2.8.1 Safety Ground

A safety ground wire is required for each AC mains input and they should be connected to the copper ground stud shown in Figure 2-2. The grounding stud on this panel is directly attached to the ground strap that runs from the grounding block located on the cabinet top to the ground block located inside the rear of the cabinet on the floor.

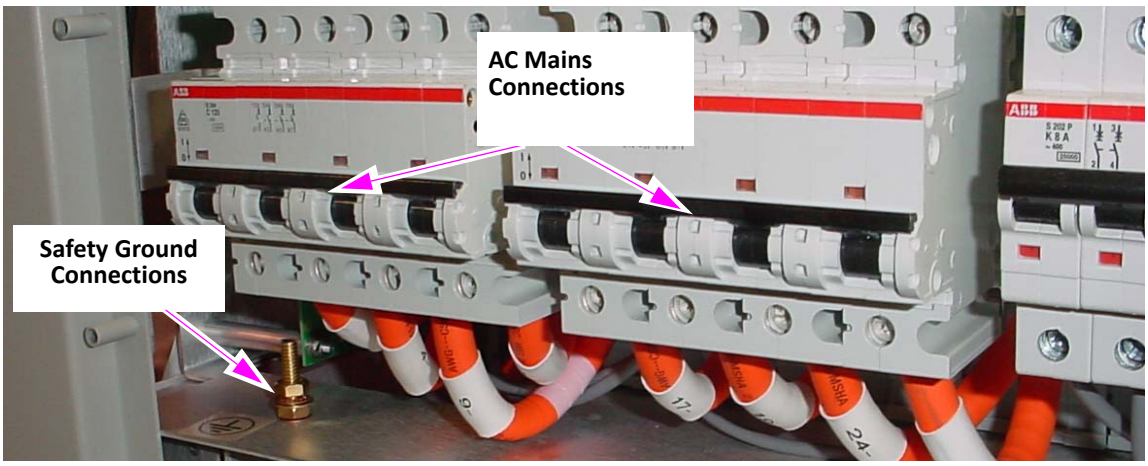

Figure 2-2 Safety Ground Connections Inside Cabinet (rear)

The Maxiva ULX Series transmitters require 3 phase 208/220/240Vac or 3 phase 380/400/415Vac at 50/60Hz. Voltage, frequency and configuration (Delta or WYE) should be identified at the time order is placed.

Caution

IF VOLTAGE VARIATIONS IN EXCESS OF ±10% ARE ANTICIPATED, THE AC MAINS INPUT MUST BE EQUIPPED WITH AUTOMATIC VOLTAGE REGULATORS (OPTIONAL EQUIPMENT) CAPABLE OF CORRECTING THE MAINS VOLTAGE.

2.8.2 AC Connections Procedure

Note

It is important that the correct voltage, frequency and connection type be applied as the MOV (metal oxide varistor) board components/ jumpers, IPA backplane jumpers, and PA backplane jumpers are configured differently for delta or wye inputs.

STEP 1 **Route the primary AC conduit(s) through clamps at the top of the transmitter cabinet.**
The top of the transmitter cabinet has pre-cut holes for clamps to secure conduit to the cabinet as shown in the outline drawing.

Note

For the following two steps the access cover at the top of the transmitter and the panel covering the circuit breakers in the top rear of the transmitter should be removed to facilitate connection of the AC mains to the transmitter.

STEP 2 **Connect the AC wires to the primary AC terminal blocks CB23 and CB24** (for higher power levels two AC inputs are required)**.** Refer to the wiring diagram for details on specific power levels. The AC input wires will connect to CB23 and CB24 located behind the access plate on top rear of the cabinet (another

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panel on the top of the transmitter see Figure 2-7, below must be removed for access). It will be necessary to use a straight slot screw driver to loosen the circuit breaker screws to allow insertion of the cables. Once the cable is in place tighten the screws to secure the cables firmly in place.

Caution

BE CERTAIN THAT THE INSULATION ON EACH AC SUPPLY CABLE HAS BEEN SUFFICIENTLY CUT BACK TO ALLOW FULL CONTACT BETWEEN THE CONNECTOR BLOCK AND THE COPPER CABLE. FAILURE TO REMOVE THE INSULATION MAY RESULT IN HEATING AND FAILURE OF THE CONNECTION.

STEP 3 **Connect the safety ground wire to the stud shown in Figure 2-2.** There should be separate safety ground wires for each AC mains input.

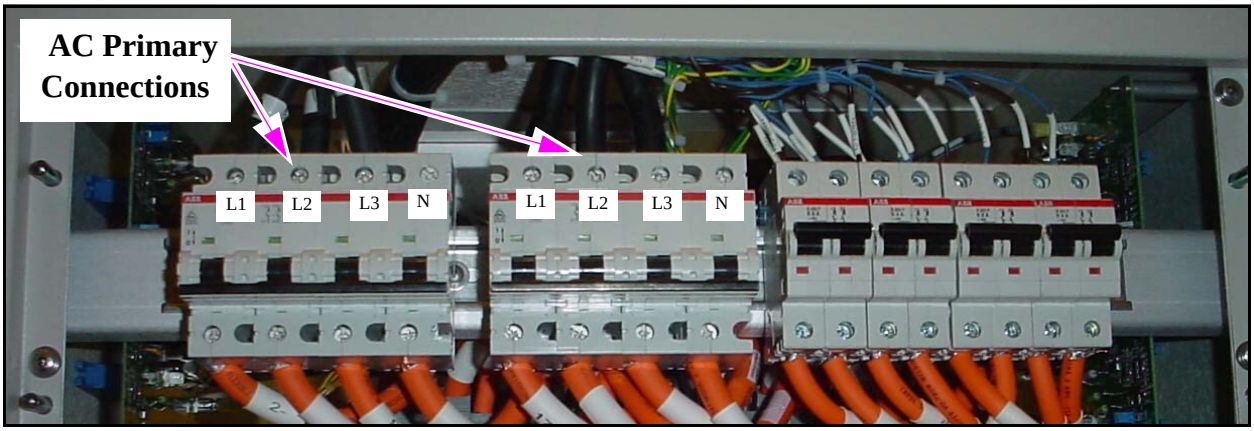

Figure 2-3 AC Connections to Terminal Blocks CB23 & CB24

STEP 4 **Verify that primary AC line voltage is correct for the MOV board and jumper configurations.** Measure the primary AC line voltage from phase to phase and record it in the blanks below. The transmitter was setup in the factory with either 208/220/240VAC Delta/Wye, or 380/400/415VAC WYE. The IPA and PA backplanes jumpers, TB1 and TB2 jumpers in the AC distribution panel, MOV board components and jumpers, will vary depending on the site AC mains configuration. The 380V-415V WYE service also requires a neutral connection from the AC mains disconnect to CB23 and CB24.

Note

The allowable wire size for CB23 and CB24 are from 14AWG to 1AWG.

STEP 5 Make sure that the transmitter is setup for the same AC power configuration that is used at the site. Check the on site measured AC voltages against the factory test data sheet or the metal ID plate affixed to the transmitter cabinet.

STEP 6 Record measured voltage for each phase and record them below.

1 to 2: _____ VAC
2 to 3: _____ VAC
1 to 3: _____ VAC

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Note

There must be less than a 10% imbalance between any one phase and the average of all three phases to allow the transmitter to operate, however the phase imbalance and frequency variation must be 5% or less to meet transmitter specifications.

STEP 7 End of procedure.

2.8.3 Checking AC Configuration

The voltage specifications on the transmitter ID panel should be compared to the supply voltages to be sure they are compatible. Should questions arise the jumpers in TB1 and TB2 on the AC distribution panel, the IPA and PA backplane jumpers (TB1, TB2, and TB3), the MOV board jumpers, and the possible neutral connection from the AC service disconnect to CB23 and CB24 can be verified. These jumpers are described in the Wiring Diagram, PA Cabinet Main Maxiva ULX 843-5601-001. Select the proper diagram for the system that is being used. Use the wiring diagrams for proper set up. The connections are also briefly described below.

- Terminal boards TB1 and TB2 on the AC distribution panel.

Figures 2-5 and 2-6, referred to below, contain outline drawings of TB1 and TB2, with black boxes representing the jumpers between segments. The critical jumpers are indicated by the dashed boxes around them.

2.8.3.1 TB1 TB2 Jumpers 10 - 16 Modules

For *208 to 240 VAC* connections in Delta or WYE, TB1 and TB2 have a jumper between terminals 5 and 6, and none between 6 and 7, see Figure 2-5, top.

For *380 to 415* VAC, connection must be WYE and the jumper is removed from between terminals 5 and 6 and installed between terminals 6 and 7, see Figure 2-5, bottom.

2.8.3.2 TB1 TB2 Jumpers 1 - 8 Modules

For *208 to 240 VAC* connections in Delta or WYE, TB1 has a jumper between terminals 5 and 6, and none between 7 and 8, see Figure 2-6, top.

For *380 to 415 VAC*, connections must be WYE and the jumper is removed from between terminals 5 and 6 and installed between terminals 7 and 8, see Figure 2-6, bottom.

Correct positioning of the jumpers ensures that 208 to 240 VAC is always applied to circuit breakers CB19 through CB22.

- Parallel MOV boards (A15A1 & A15A2). MOV board jumpers are shown on sheet 8 of the PA Cabinet Main Wiring Diagram, drawing number 843-5601-001.
- Driver and PA backplane boards. On the IPA and PA backplane boards, drawing numbers 801-0222-131 and 801-0222-101 respectively, the jumpers on TB1, TB2, and TB3 are connected between terminals 2 and 3 for 208 to 240 VAC Delta or WYE and connected between terminals 1 and 2 for 380 to 415 VAC Wye connections.
- A neutral connection is required, from the AC service entrance to CB23 and CB24 (if used) for the 380 to 415 volt WYE connection, but no neutral connection is required for the 208 to 240 volt Delta or WYE connections. 440 to 480 VAC Delta or WYE connections require a step down transformer.

Figure 2-4 is a photo of TB1 and the MOV board (on the left). These terminal boards need to be properly jumpered depending on the AC mains voltage. Figure 2-5 and Figure 2-6 are sketches that show the various configurations of the MOV and terminal block jumpers depending on AC mains and number of PA modules used in the transmitter. The MOVs and TB's are accessed by removing a cover plate on the top of the transmitter cabinet at the rear.

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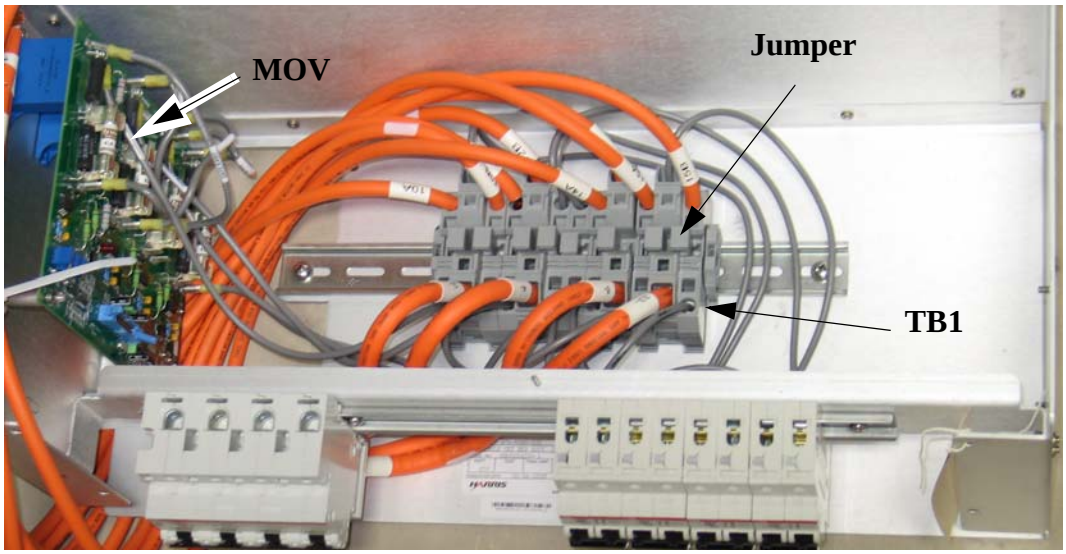

Figure 2-4 Photo of MOV & TB1

Figure 2-4 shows an AC distribution panel removed from the transmitter. TB1 in this case is for an amplifier cabinet with 8 modules or less.

Note

The dashed rectangles in Figure 2-5 and 2-6 indicate jumpers that need to be moved to change between 208-240V and 380-415V operation.

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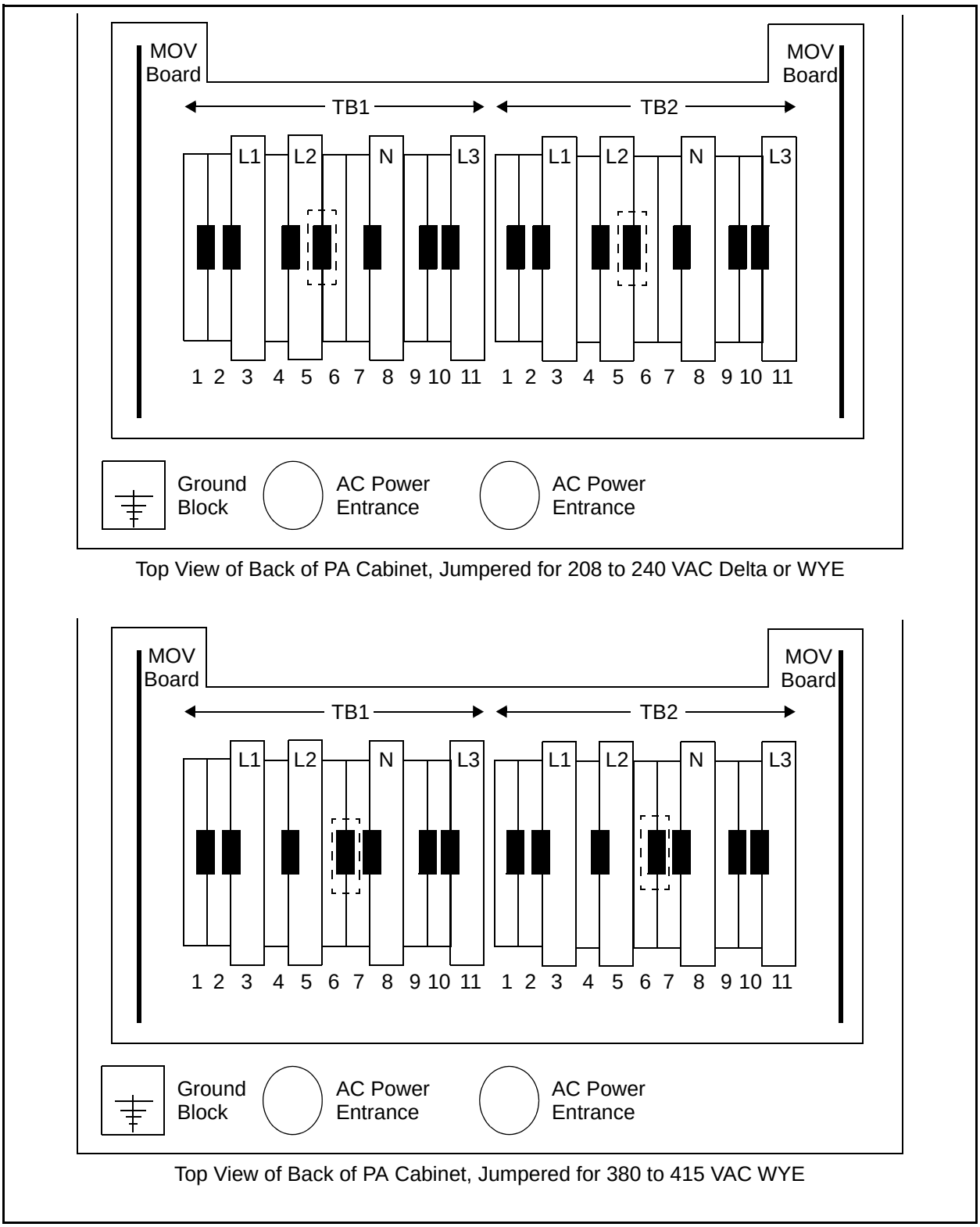

Figure 2-5 TB1 and TB2 Jumpers For Single Cabinet With 10, 12, or 16 PA Modules

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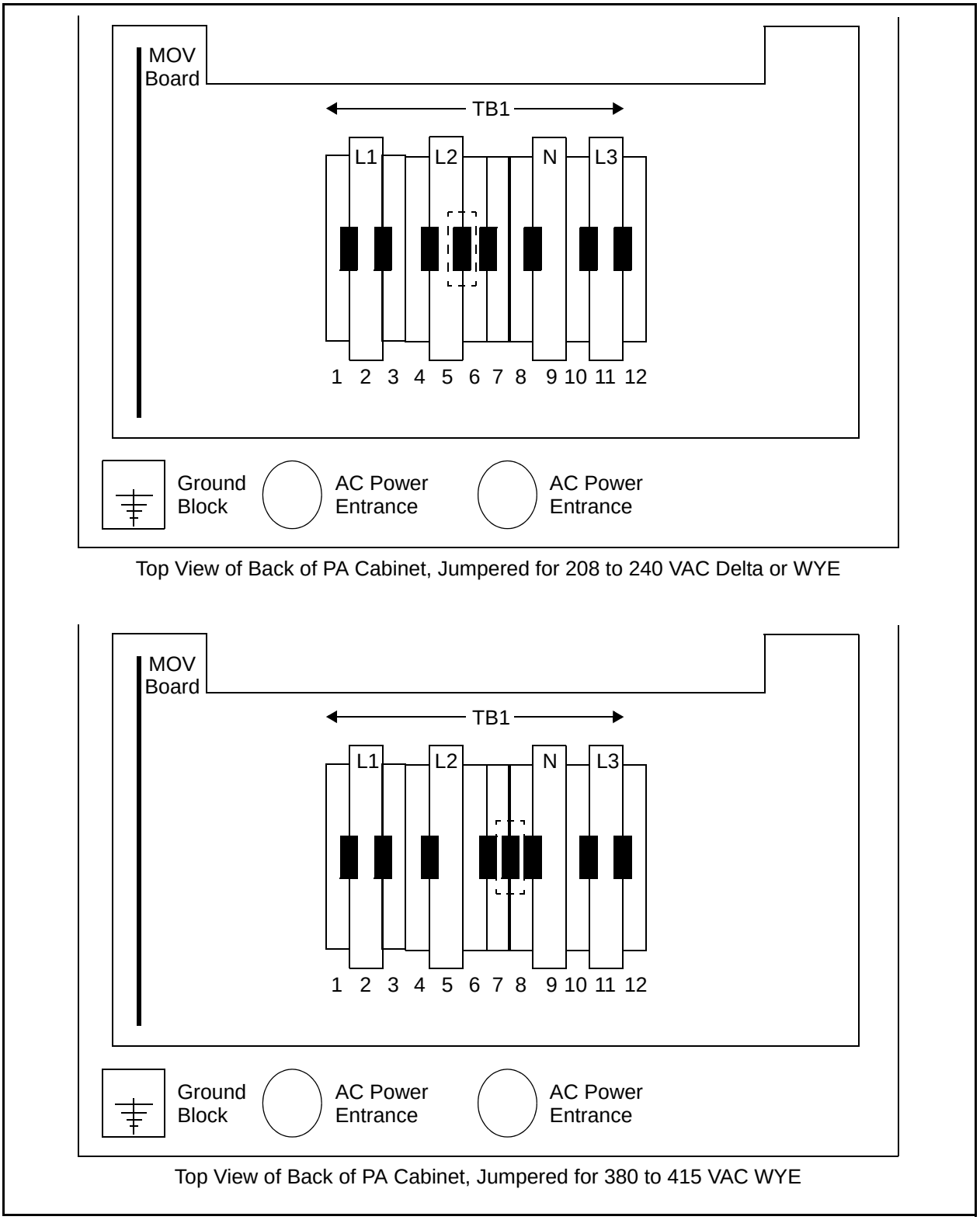

Figure 2-6 TB1 and TB2 Jumpers For Single Cabinet With 1 to 8 PA Modules

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2.9 Signal and Ground Connections

Note

Control and signal wires should never be run in the same conduit with any AC wiring. A separate conduit should be used for control/signal cables.

STEP 1 **Connect the video/audio (analog) or transport stream (digital) and reference inputs to the customer IO panel at the top of the transmitter (see Figure 2-7).** Refer to the tables below for exciter A and B connections which differ for analog and digital applications.

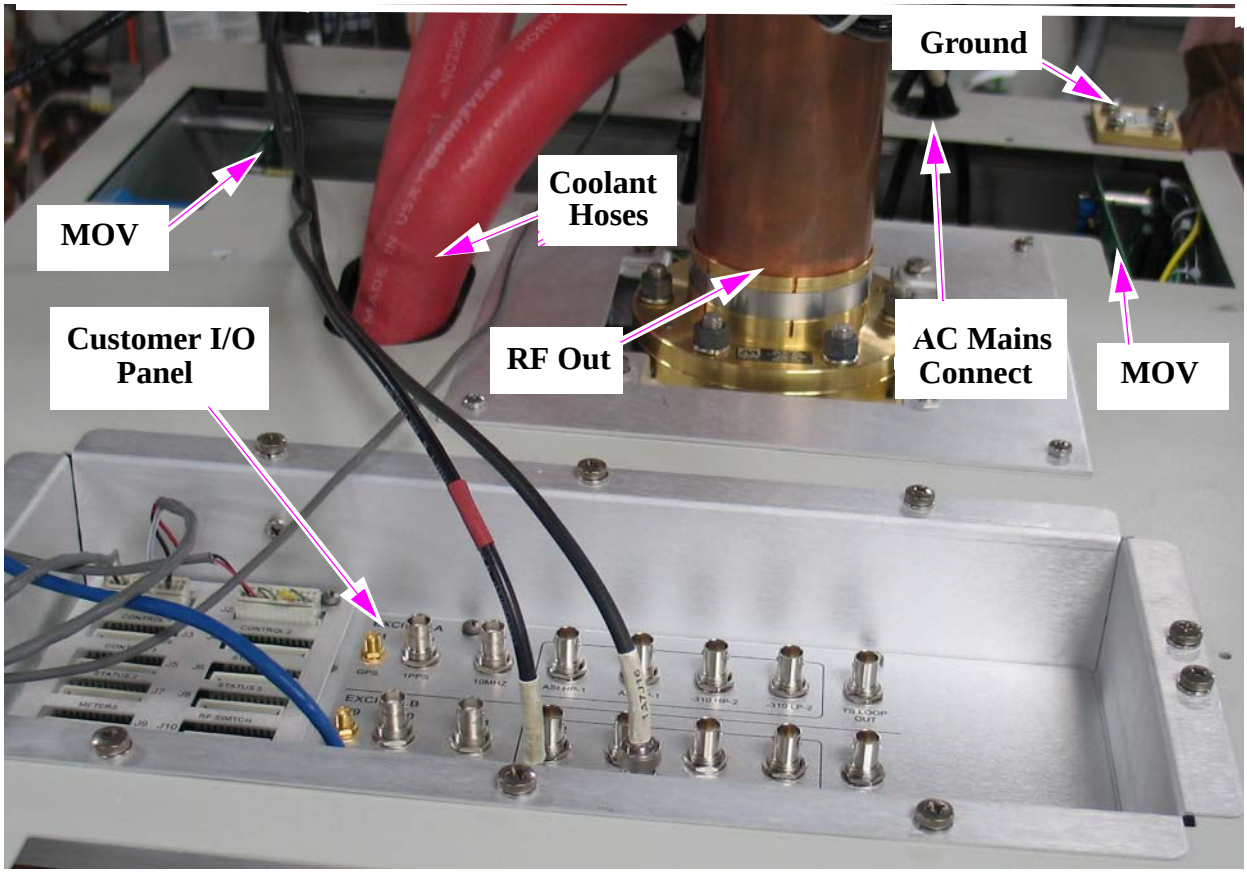

Figure 2-7 Customer I/O Panel (top of digital transmitter)

Table 2-5 I/O panel connections for exciter A/B-analog

Jack	Connector	Label
J1	SMA - 50Ω	GPS (antenna)
J2	BNC - 50Ω	1PPS
J3	BNC - 50Ω	10 MHZ
J4	BNC - 75Ω	VIDEO IN
J5	BNC - 75Ω	VIDEO AUX
J6	BNC - 75Ω	AUDIO COMP
J7	XLR Connector (female)	AUDIO MAIN L/R
J8	XLR Connector (female)	AUDIO AUX L/R

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Table 2-6 I/O panel connections for exciter A/B-digital

Jack	Connector	Label
J1	SMA - 50Ω	GPS (antenna)
J2	BNC - 50Ω	1PPS
J3	BNC - 50Ω	10 MHZ
J4	BNC - 75Ω	ASI HP1
J5	BNC - 75Ω	ASI LP-1
J6	BNC - 75Ω	310 HP-2
J7	BNC - 75Ω	310 LP-2
J8	BNC - 75Ω	TS Loop Out

The digital TS input connectors (J4 - J7) are type BNC, female. TS input connector impedances are 75 ohms. Belden 8281 or similar high-quality video cable can be used to deliver this signal to the transmitter over a distance of up to 1000 feet. See Figure 2-8 on page 2-18 and Section Table 2-7 on page 2-18 for more detail.

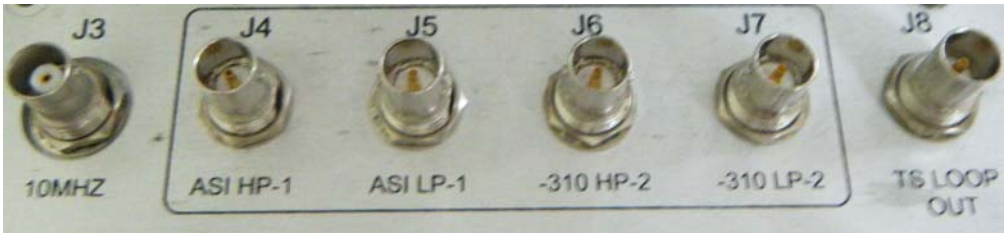

Figure 2-8 TS Connections on Cabinet Top

Table 2-7 Digital TS Inputs

Connector Label	ATSC	DVBT/CTTB/CMMB/ISDBT	DVBT Hierarchial
J4 ASI HP1	ASI Primary	ASI Primary	ASI High Priority Primary
J5 ASI LP-1	ASI Auxiliary	Not used	ASI Low Priority Primary
J6 -310 HP2	SMPTE Primary	ASI Auxiliary	ASI High Priority Auxiliary
J7 -310 LP-2	SMPTE Auxiliary	Not used	ASI Low Priority Auxiliary

System that have dual exciters will have two sets of these connectors.

:

Table 2-8 Connectors for Audio Main L/R J7 & Audio Aux L/R J8

Pin No.	Designation
1	Ground
2	Left +/Mono 1+
3	Left -/Mono 1-
4	Right +/Mono 2 +
5	Right -/Mono 2 -

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STEP 2 **Connect sample cables from forward and reflected directional couplers (at the system output, after the filter), from reject load directional couplers, and from the PA RTAC to the customer I/O panel at the top of the cabinet.** These samples are listed in Table 2-9. These samples must be calibrated using the GUI after initial turn-on (see "5.9 Analog Power Calibrations" on page 5-12 or "5.10 Digital Power Calibrations" on page 5-21). The forward and reflected sample cables and RTAC post filter sample cables are not supplied since the required lengths must be determined at each site.

Note

Refer to the Apex M2X technical manual for RTAC sample levels. RTAC sample lev es are typically adjusted to be -5 dBm at the exciter inputs.

Table 2-9 RF Samples Connections on Customer I/O Panel

Jack	Connector	Label
J17	N - 50 Ω	SYS FWD
J18	N - 50 Ω	SYS REF
J19	N - 50 Ω	REJECT 1
J20	N - 50 Ω	REJECT 2
J21	N - 50 Ω	REJECT 3
J22	N - 50 Ω	PA RTAC

Note

J23 is the WAN/LAN connector.

STEP 3 **Connect a ground strap from each cabinet's E1 block (located at the bottom, rear, center inside each cabinet) to the station ground.** The E1 block is shown in Figure 2-9. A roll of copper strapping is shipped with the transmitter. Roll this strap out and attach it beneath the cabinet ground block in the cabinet and to station ground on the other. If any additional copper strap is needed, it should be at least 5cm wide and 0.5mm thick.There is an additional E1 block located on top of each cabinet (see Figure 2-7) for additional grounding as needed.

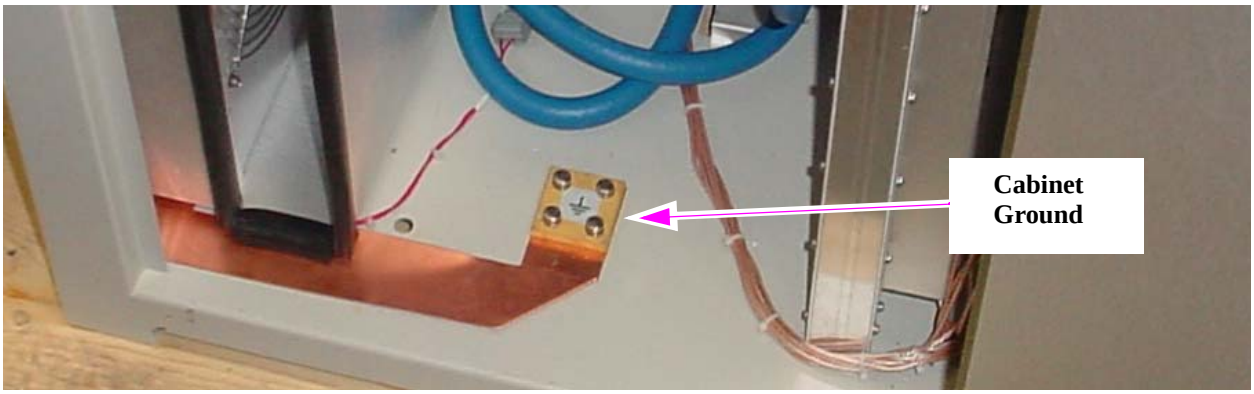

Figure 2-9 Cabinet Ground Connection Block

STEP 4 End of procedure.

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2.10 Intercabinet Connections

For multi-cabinet transmitter models, the intercabinet connections will need to be installed next. See External Wiring Diagram for reference.

2.11 External Interlock Connections

2.11.1 Interlock Connector on Customer I/O Panel

The interlock connector (J2 with 12 pins) is located on the customer I/O panel at the top of the transmitter (see Figure 2-10 on page 2-21). The WAGO style connector has contacts for up to four external interlocks. Two are fault-off interlocks named system safety interlock and cabinet safety interlock. The other two are RF-mute interlocks named system RF mute interlock and cabinet RF mute interlock. More interlocks may be incorporated by placing 2 or more interlocks in series. The transmitter is shipped from the factory with jumpers in the external interlock positions which will allow the transmitter to operate without external interlock connections.

The external wiring diagram shows that interlock #1, J2-2 to J2-3, is used by a 3port patch panel or possibly a motorized switch. The external interlock circuits require a closed connection on the following interlock connector terminals to allow the transmitter to turn on:

- J2 pins 2-3 system safety interlock (for 3 port patch panel or switch)
- J2 pins 5-6 system RF mute interlock (for load thermal interlock)
- J2 pins 8-9 cabinet safety interlock
- J2 pins 11-12 cabinet RF mute interlock

2.11.2 Fault-Off Interlocks (Safety Interlocks)

System safety interlocks are fault-off interlocks and will shut the transmitter off if opened. They are provided for use in protection of personnel. Cabinet safety interlocks are also fault-off interlocks and can be used in multi-cabinet transmitters to fault-off individual PA cabinets. A manual turn on is required to recover from the fault-off conditions caused by system or cabinet safety interlocks.

Table 2-10 J2 Interlock Connector on Customer I/O Board

Pin Number	Description
1	NC
2	System Safety Interlock
3	System Safety Interlock Return
4	NC
5	System RF Mute Interlock
6	System RF Mute Interlock Return
7	NC
8	Cabinet Safety Interlock
9	Cabinet Safety Interlock Return
10	NC
11	Cabinet RF Mute Interlock
12	Cabinet RF Mute Interlock Return

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2.11.3 RF Mute External Interlock Connections (J2)

There are 2 interlock connections that can be used to apply a temporary RF mute condition (vs. a fault-off condition as discussed above). The transmitter will RF mute when the interlock is open and automatically unmute when the interlock is restored to a close condition. These are:

- J2-5 to J2-6 (for test load thermal interlock)
- J2-11 to J2-12

Warning

RF MUTE INTERLOCKS SHOULD NOT TO BE USED IN ANY SITUATION WHERE PROTECTION OF PERSONNEL IS DESIRED.

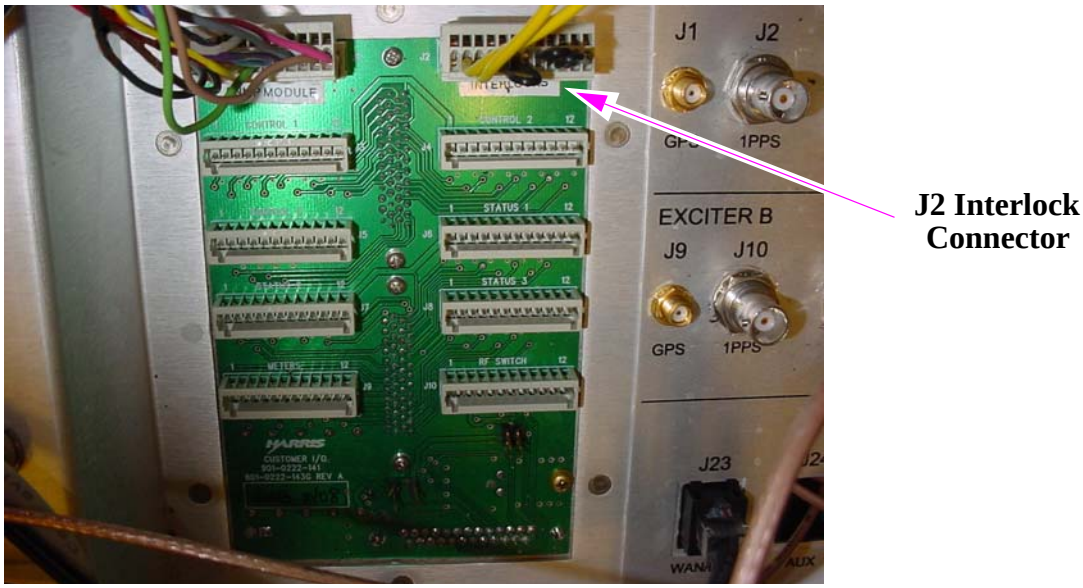

Figure 2-10 Customer I/O Board - Top of Transmitter

The transmitter is shipped from the factory with jumpers in the RF mute and safety interlock positions on J2 which allow the transmitter to operate without external interlock connected.

2.12 Cooling System Activation

The liquid cooling system (external to the transmitter) consists of an air cooled heat exchanger, two pumps and an integrated electrical control system. The heat exchanger capacity and size pump sizes will vary depending on the number of PA modules in the PA cabinet.

Fan control is accomplished via electronic inverter/controllers (one per fan) in the pump control panel. The controllers vary fan speed based on coolant temperature measured in the pump module outlet pipe .

Pump operation is automatically controlled using inverter/controllers (one per pump). There are two modes of pump operation, “Local”, and “Remote”. The inverter/controllers interface with the transmitter’s “Pump Control Interface” (PCI). The inverter/controllers receive signals from the PCI and send signals to the PCI.

Note

For additional cooling system start up information see the pump module, heat exchanger and inverter/ controller technical manuals. Additional cooling system information is also provided in Appendix B (this manual).

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2.12.1 Heat Exchanger & Pump Module Start-up

The electrical installation should be completed and should be in accordance with the National Electrical Code and any local codes and regulations. The incoming power supply can be 208 to 240V-3Ph-50 or 60Hz, or 380 to 415V-3Ph-50 or 60Hz. Exact line voltage and configuration should have been specified at the time the order was placed. Fan and pump motors are three phase and have current overload protection provided by the inverter/controllers.

Prior to start-up, each fan motor should be checked for freedom of movement and to verify that the fan blade is securely fastened to the motor shaft. Pump and fan direction of rotation must be checked at the initial power up of the pump module and heat exchanger. Verification of pump and fan rotation is outlined in the HE pump module manual 888-2625-001 Section 2.6.

Caution

INCORRECT (REVERSE) ROTATION OF THE PUMPS OR FANS WILL CAUSE POOR COOLANT OR AIR FLOW AND MAY DAMAGE THE DEVICES. CORRECT PUMP ROTATION BY SWITCHING ANY TWO OF THE AC LINES AT THE OUTPUT OF INVERTERS. CORRECT ROTATION OF THE FANS BY SWAPPING TWO OF THE AC LINES FEEDING THE FANS.

Fans and motors are direct connected. Motors are permanently lubricated for the life of the motor. All pumps have maintenance-free pump seals.

Note

Job site environmental conditions should be evaluated periodically to maintain operational reliability. Schedule maintenance activities to accommodate changing environmental conditions at the site.

2.12.2 Charging Closed Loop Cooling System

Initial charging of the closed loop cooling system is outlined in Section 2. 6 of the HE pump module technical manual. Section 2. 7 includes instructions for charging the system using circulating pump B. Refer to those instructions to charge the system.

2.12.3 Initial System Leak Testing

Once the system is charged with water perform leak testing prior to charging the system with the 50/50 glycol/ distilled water mixture.

Check immediately for any leaks at the following cooling system points.

- Transmitter inlet and outlet pipe connections
- Pump module inlet and outlet pipe connections
- Heat exchanger inlet and outlet pipe connections
- All solder joints, system valves and drain valves

Repair any detected leaks. If leaks have developed, depending upon the given leak's location, water may have to be drained from the system before making repairs.

2.12.4 Initial System Flushing

Once the cooling system has been determined to be free of leaks it may need to be cleaned and flushed before continuing the installation.

STEP 1 **Drain all water from system.** Monitor the level of water that is returned to the container to determine trapped water in system. To more easily drain the system open all of the system and cabinet drain and vent valves. Once draining is complete close all cabinet drain valves. The charge pump, if used, can be reversed to aid in draining the system.

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STEP 2 **Closely examine the water that was drained from the system.** If it is relatively clean, proceed to fill the system with the glycol/distilled water mixture. If it is dirty another fill and flush with water may be needed. Systems that are extremely dirty may need additional flushing with a cleaning solution.

STEP 3 End of procedure.

2.12.5 Cooling System Cleaning

STEP 1 Completely drain the water from the system.

STEP 2 **Create cleansing solution.** Using a mixture of distilled water and a cleaning solution (a mixture of 1 cup of a trisodium phosphate-based (low suds) detergent, such as Cascade, thoroughly mixed in 2 gallons of warm water), proceed with the following steps.

STEP 3 **Pour the cleaning solution through a porous cloth (to filter out clumps of detergent) into the container (reservoir) of clean distilled water and mix thoroughly to completely dissolve all detergent.**

In cold environments the effectiveness of the cleaning mixture is enhanced if it is heated. Heating can be accomplished by installing a propane heater underneath the heat exchanger and temporarily enclosing the unit with a tarp to heat up the cleaning mixture as it circulates cleaner solution through the exchanger.

STEP 4 Use the charge pump or circulating pump to fill the system with the cleaning solution. Monitor the sight glass to confirm fluid level and lack of air bubbles to confirm charge.

STEP 5 Run the system for 40 minutes. Alternate pumps A and B for 20 minutes each.

STEP 6 Turn off pump. Close bypass valve and fully open cabinet intake and outlet valves to allow cleaning solution to flow through transmitter cabinet.

STEP 7 **Run the system for an additional 20 minutes.** Alternate pumps A and B for 10 minutes each. Note flow rate of system.

STEP 8 **Drain the system**. To drain the system open the drain hoses and the system vent valves. Once draining is complete close all drain and vent valves.

STEP 9 **Dispose of cleaning solution in container and rinse.** Refill the container with clean distilled water.

STEP 10 Clean the strainer screen.

STEP 11 End of procedure.

2.12.6 Cooling System Flushing

Flush the system to remove the contaminated water before the initial transmitter operation. Before charging the system with the glycol/water mixture it must be purged of all cleaning solution residue.

The flushing is accomplished by alternately filling, running and draining the system, two to four (or more if needed) times using distilled water. The following steps outline the flushing process.

The length of flushing time and number of fill/drain cycles needed to achieve desired water quality will vary with system size and the amount of residual (trapped) liquid in the system. Residual liquid is trapped in the system and cannot be removed when the system is drained. Smaller systems with less residual liquid may require a lower number of flush cycles.

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STEP 1 **Fill system with distilled water.**

STEP 2 **Run system for approximately 20 minutes.** Alternate pumps A and B for 10 minutes each.

STEP 3 **Drain system**. Drain valves must be opened at each low point in the system, along with the vent valves at the system high points, to ensure full drainage.

STEP 4 Repeat above steps (flushes) until coolant is clear of contaminants and detergent residue. Typically two or three distilled water flushes are needed.

STEP 5 End of procedure.

2.12.7 Final Cooling System Fill

Caution

THE SYSTEM MUST BE TESTED FOR LEAKS AGAIN ONCE THE REQUIRED 50/50 GLYCOL/WATER MIXTURE HAS FILLED THE ENTIRE SYSTEM. A GLYCOL/WATER MIXTURE WILL EXPOSE SMALL LEAKS WHICH ARE NOT EVIDENT WHEN TESTING FOR LEAKS WITH PURE WATER OR AIR.

STEP 1 **Charge the cooling system with equal amounts of coolant and water**. The amount of residual water in the system must be taken into account when adding glycol and water to the system. The amount of residual water (water that remains trapped in the system and can't be readily removed by opening drain valves) and will vary from system to system. The amount of residual water can be estimated if the amount of initial fill water was tracked and compared to the amount of re-fill water required during the flushing. If the amount of residual water is significant and is ignored the concentration of coolant may be less than the specified 50/50 mixture. Extra glycol, equal to the amount of trapped water in the system, must be added in order to achieve the proper glycol water mixture.

STEP 2 **Run pumps for several minutes and open automatic vent valves (in pump module and system air purgers) to remove all air from the system.** Alternate pumps A and B.

STEP 3 **Add additional coolant to the system as required. Frequently check the static pressure of the cooling system with the pumps deenergized.** The static pressure of the system will drop as the trapped air is bled from the system. The cooling system must be charged with coolant mixture to a pressure of 15 psig.

STEP 4 Recheck system for leaks.

STEP 5 Repeat steps 1 through 4 until coolant level and static pressure have stabilized.

STEP 6 **Check system sight tube to be sure that all air has been vented and the system is full of coolant.** Drain a sample of coolant from the system and check the 50/50 mixture. Use a conventional float hydrometer and a jar (for ethylene glycol only) or a MISCO DFR 200 or equivalent digital refractometer to verify the 50/50 mixture. The hydrometer should be capable of measuring specific gravity in the 1.02 to 1.08 range. Information regarding specific gravity measurement is given in Appendix B.

STEP 7 End of procedure.

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2.13 Install PA & IPA Modules

STEP 1 Be sure the PA module breakers (in rear of cabinet as shown in Figure 2-11) are in the OFF position.

Figure 2-11 PA & IPA (driver) Module Circuit Breakers

Warning

THE PA MODULES ARE LARGE AND RELATIVELY HEAVY, WEIGHING APPROXIMATELY 22KG. (49 LBS) CARE SHOULD BE TAKEN TO AVOID PERSONAL INJURY AND/OR DAMAGE TO THE MODULES.

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STEP 2 **Prior to inserting modules remove all packing surrounding the connectors in rear of the PA cabinet and on the PA modules. Visually inspect the connectors in the cabinet and on the module back to be sure they are undamaged and free of debris of any kind.**

STEP 3 **Refer to the factory test data to identify which modules go in which slot location.** Refer to the outline drawing to identify slot numbers and module numbering. Module location will vary with transmitter model and is outlined in "Table 5-1 PA Slot Allocations for Single Cabinet Models" on page 5-2.

STEP 4 **Place the PA and IPA modules into the cabinet.** When lifting modules into position, place one arm beneath the module, supporting it with that arm while holding the side of the module with the other hand. Be sure to position the module so the RF connector is to the left rear as it slides into the rack. Slide the module into the rack until contact is felt with the connectors in the rack. Move the module from side to side to insure connectors are seated, then evenly and firmly push the modules fully into the rack. *Do not slam the modules into the rack.*

Note

PA cabinets, with eight or less PA modules built after May 2011 use modified IPA modules. These IPA modules can only be installed in slots 9 & 10. All other transmitters use IPA (driver) and PA modules that can be placed into any of the IPA (driver) or PA module slots but it is advisable to place them in the same location in which they were tested. The module location is given in the factory test data that ships with each transmitter.

STEP 5 Be sure that the module is fully seated and then install and tighten the module hold down screws with a #2 phillips screwdriver.

Caution

IF THE MODULES DO NOT SEAT WITH MODERATE PRESSURE REMOVE THE MODULE AND CHECK FOR INTERFERENCE. IF MISALIGNMENT IS SUSPECTED SEE THE MODULE/RACK ALIGNMENT PROCEDURE IN SECTION 5. DO NOT FORCE MODULES INTO THE RACK AS THIS MAY CAUSE DAMAGE TO THE COOLANT OR RF CONNECTORS ON THE BACK OF THE MODULE OR IN THE RACK.

Warning

THE MAXIVA PA MODULES ARE DESIGNED TO HANDLE VERY HIGH TEMPERATURES AND MAY BE EXTREMELY HOT, UP TO 32^{O} C (90^{O} F) ABOVE ROOM TEMPERATURE. DO NOT TOUCH THE MODULES WITH BARE HANDS AFTER THE TRANSMITTER HAS BEEN RUNNING. SPECIAL GLOVES CAN BE PURCHASED , PART #0990006483 OR GRAINGER ITEM #4JF36.

STEP 6 **Verify all drain and vent valves are closed and make sure coolant valves are open before proceeding with the initial turn on**.

STEP 7 Verify that the cooling system static pressure is 10-15 psig with pumps off. Check the sight glass to verify the coolant level and lack of air bubbles with pumps running.

Note

Each PA module that is installed may introduce air into the system. The system will likely need to be recharged after modules are installed. The site glass should be checked for fluid level and for air bubbles prior to turning on the transmitter RF. Low coolant level or bubbles in the sight glass indicate that the cooling system needs to be recharged.

STEP 8 End of procedure.

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2.14 Initial Transmitter Setup

Read and understand the entire initial turn-on procedure before starting. Detailed use of GUI screens is described in Section-3 Operation.

STEP 1 **Insure that the 3 phase AC mains has been connected to the transmitter and cooling system.** Be ready to quickly disconnect the power if necessary.

STEP 2 Engage the primary AC breaker switch(es) CB23 & CB24 on the AC Mains Input Assembly at the rear of each transmitter cabinet.

STEP 3 Turn on the control circuit breakers CB19 and CB20. The Control breakers are located at the cabinet rear. This will activate the TCU power supplies, fans, and predrivers. The predrivers also have On/Off switches on the rear of the predriver chassis which must be turned on.

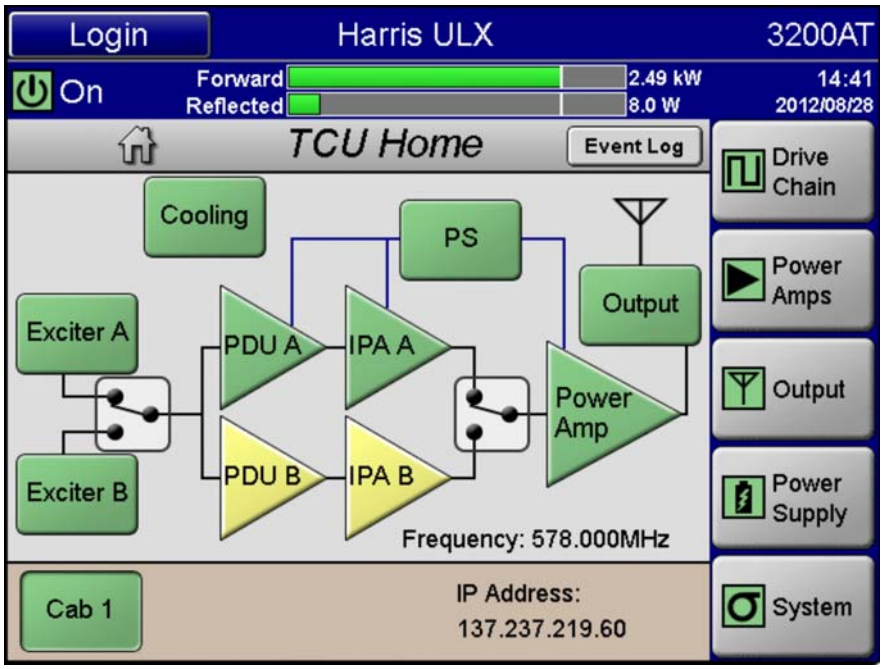

Figure 2-12 Home Page

STEP 4 Turn on exciter circuit breakers CB21 & CB22.

STEP 5 **Check the TCU low voltage power supplies and AC mains voltages.** Press the PS (power supply) button to view the PS screen shown in Figure 2-12. Check for TCU +1.2 , +2.5 voltages, shown in Figure 2-13. The AC Mains readings displayed should be close to the measured AC voltages.

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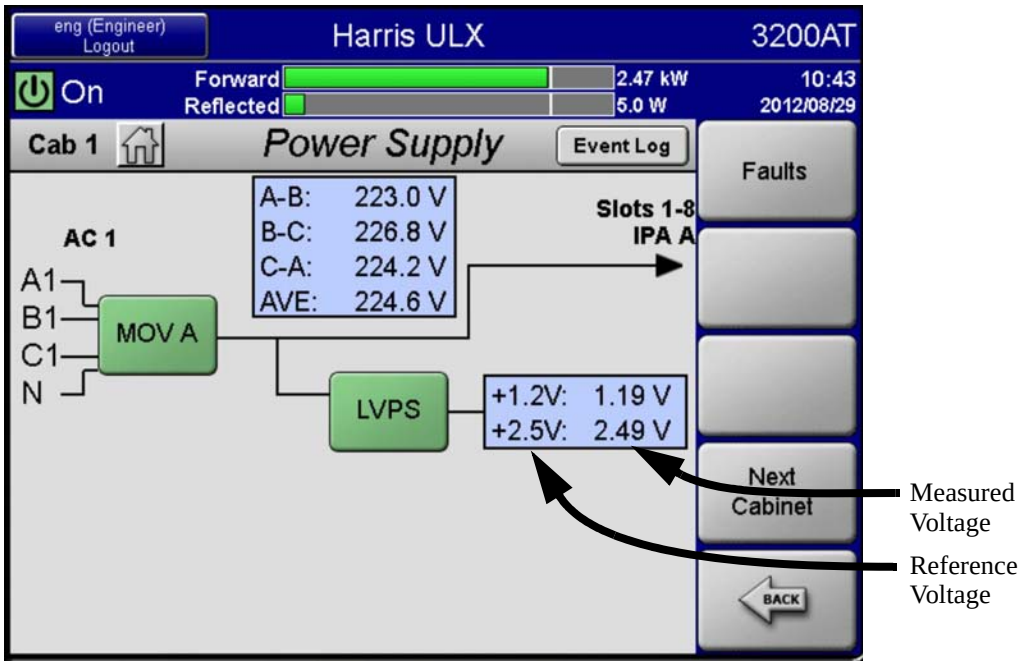

Figure 2-13 Power Supply Screen

STEP 6 Press the FAULTS button to check for power supply faults. There should be no red indications or faults present. If a fault is present, see Section 6, Diagnostics for more information.The PS Faults screen is shown in Figure 2-14.

Note

A COMMON FAULT IS A 3 PHASE SEQUENCE FAULT, INDICATING THE 3 PHASES HAVE BEEN CONNECTED IN THE WRONG SEQUENCE. IF THIS IS PRESENT, REMOVE ALL PRIMARY POWER TO THE TRANSMITTER AND SWITCH ANY 2 LINE VOLTAGE WIRES ON TRANSMITTER TERMINAL BLOCK CB23 AND OR CB24.

The 3 phase AC sequence fault can be displayed for either AC1 or AC2 inputs on the PS Faults screen. When faulted the AC Phase Sequence line is displayed with a red background.

Note

PA cabinets with more than eight PA modules require two AC mains inputs. When present both AC 1 and AC 2 faults are listed on the PS Faults screen.

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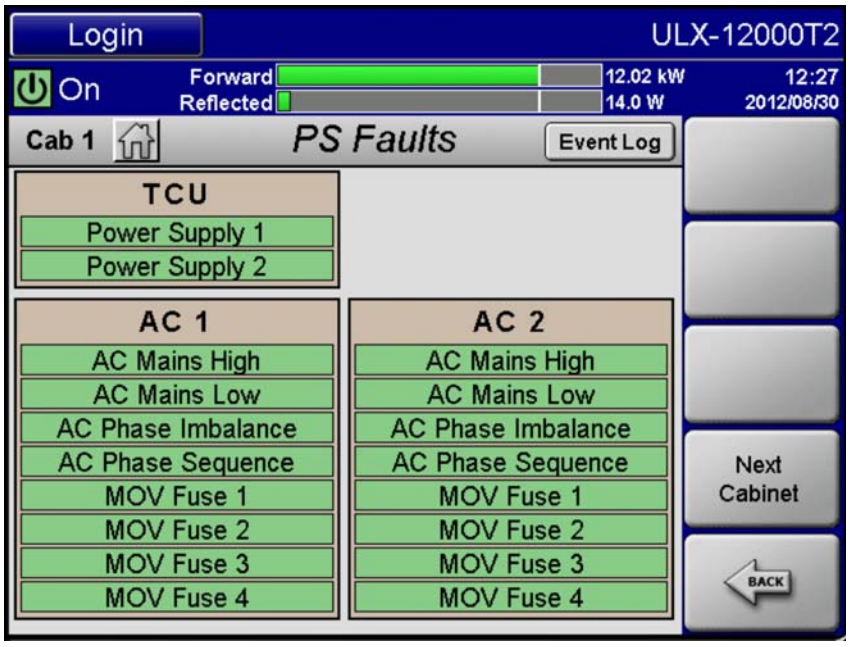

Figure 2-14 PS Faults Screen

STEP 7 **Customize the transmitter System Setup.** System>System Service>System Setup on the GUI. The System Setup screen displays the settings for System Pwr Out, Center Frequency (visual carrier for analog systems), Modulation Type, AC Line Volt (VAC), Number of exciters, Number of Cabinets and External RF Switch. Touch the screen at each field to enter the data pertinent to the setting. The System Setup screen is shown in Figure 3-25 on page 3-22.

STEP 8 **Customize the cabinet Setup.** Press System>System Service>System Setup>Cabinet Setup on the GUI. Touch the screen at each field to enter the correct data for CAB Pwr Out (W), Number of PA's, Number of IPA's and Cooling Pumps (number present). The Cabinet Setup screen is shown in Figure 3-29 on page 3-26.

STEP 9 End of procedure.

2.15 Cooling System Setup

Follow the remaining steps to complete the cooling system setup.

2.15.1 Setting the Transmitter Flow Rate

The coolant flow rate is determined by the HE pump module inverter/controller frequency. If other types of pump module are used the flow rate is controlled by adjustment of the cabinet inlet valve.

The flow rate can be checked via the transmitter GUI. Press SYSTEM to display the System GUI screen. The bottom line in the blue box under the Cab 1 label displays the transmitter flow rate.

The recommended flow rate varies with the number of PA modules and is listed below. Refer to the HE pump module manual section 3.11 on page 3-2 for instructions on setting up the inverter/controllers to produce the desired transmitter flow rate.

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Note

Actual flow rate may deviate from recommended depending on site specifics like pipe diameter, number of elbows, and run length. The flow rate must be above the trip point level in order to prevent frequent faults and pump switches. .

Table 2-11 Typical Transmitter Flow Rates

Quantity of PA Modules	Minimum Coolant Flow Rate Trip Point (LPM)	Recommended Coolant Flow Rate (LPM)	Typical Pump Frequency Range (Hz)
2	10	14	15-20
3	19	27	15-20
4	23	32	15-25
6	31	43	20-30
8	38	53	25-35
10	46	65	TBD
12	53	75	TBD
16	70	100	TBD

Note

If the pump is unable to deliver the required flow rate, check for correct wiring of the 3 AC phases. Incorrect wiring of the 3-phase sequence would allow the pumps to operate but with much degraded performance.

2.15.1.1 Confirmation of Auto Pump Switching

Once the inverter/controller LL (low level) is set the operation of the transmitter flow sensor can be confirmed by the following:

STEP 1 Set HE pump module to Remote.

STEP 2 **Use System page GUI to select Auto pump control mode.** This activates automatic pump switching.

STEP 3 Turn transmitter on.

STEP 4 **Reduce the flow rate through the cabinet by slowly closing the cabinet coolant inlet valve.** When the flow rate through the cabinet falls below the trip point the flow warning should activate and the system should switch to the other pump.

STEP 5 **Go back to the nominal flow rate recommended for the cabinet by slowly opening the cabinet inlet valve.** The warning should go away.

STEP 6 End of procedure.

2.15.2 Heat Exchanger Fan Control

Fan operation is controlled by the fan inverter/controllers. The controllers automatically change the fan speed based on temperature sensed in the heat exchanger supply line. The fans turn at a low speed when the coolant temperature is >30 degrees C. and power is applied to the transmitter and pump module. The fan inverter/controllers have been programmed at the factory so no setup is required.

Note

If fan activation is needed to check fan rotation but the transmitter is not available, the fan inverter/controllers must be set up for manual control to allow fan activation. This is accomplished by following the procedure outlined in the HE pump module technical manual 888-2625-001 Section 3.1.4 on page 3-5.

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2.16 M2X Exciter Setup

See M2X exciter manual to set exciter parameters. There are several versions of M2X manuals depending on modulation type. M2X exciter manual part numbers are listed in Section 2.2 on page 2-1.

DVB-T modulation requires a valid transport stream to allow RF output. If a transport stream is not available then the PRBS test mode can be activated via the M2X modulator screens.

M2X exciters typically require on-site installation of the real time clock battery to maintain time and date on the system should AC power be disrupted. Refer to the M2X manual for detailed battery installation instructions.

Note

Exciter A is always factory installed as the upper exciter unit. The optional exciter B is installed immediately above the TCU and below the top exciter unit (see layout photo Figure 1-1 on page 1-2).

2.17 RF Initial Turn On

Caution

THE TRANSMITTER SHOULD BE INITIALLY POWERED INTO THE TEST LOAD.

STEP 1 Turn on AC mains 1 & 2, PA Contactor 1 & 2, Control 1 & 2, and Exciter 1 & 2 breakers located on the top left back of the transmitter. Transmitters with fewer PA modules will not have two of each breaker. It will take a few minutes for the TCU and exciters to turn on.

STEP 2 **Log in to the TCU by pressing the Login button on the upper left corner of the screen.** Instructions for initial login are given in 3.2.2 on page 3-2. The transmitter should remain in Auto power control mode throughout this procedure.

STEP 3 **Press OUPUT on the GUI to view the Output screen** (see Figure 2-16 on page 2-32). This screen shows the forward and reflected powers for the cabinet and system. System power is typically calibrated on site after initial turn on). The ALC (auto level control) voltage level is also indicated.

STEP 4 **Turn down the transmitter output power level prior to initial start up.** Hold down the LOWER button on the TCU control panel until the Set Cab Fwd Pwr (W) value (see the output screen in Figure 2-16 on page 2-32) reads 500W. This assures that the transmitter will initially come on at a low RF output level.

STEP 5 Switch ON the IPA (driver) and PA circuit breakers IPA A-B and PA PA slots 1-8 and 11-18 (the number of PA modules depends on the transmitter model) inside the cabinet rear on the left side (refer to Figure 2-11 on page 2-25).

STEP 6 **Press the transmitter ON button**.

STEP 7 **Verify that the cabinet and system (if calibrated) reflected power levels displayed on the Output screen are low (typically <50 W)**.

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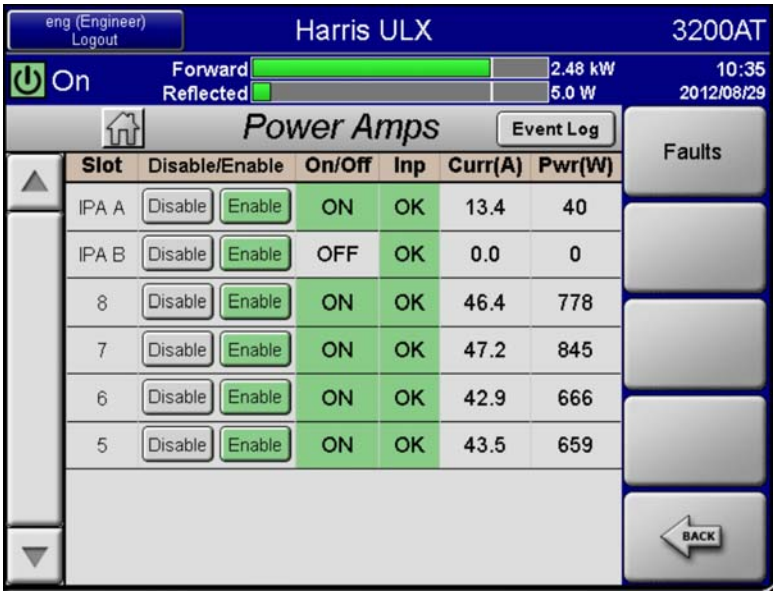

Figure 2-15 Power Amps Screen

STEP 8 See Figure 2-15. **All IPAs and PAs should show a green (OK) or white (indicating Off) status indication on the GUI (Power Amps screens)**.

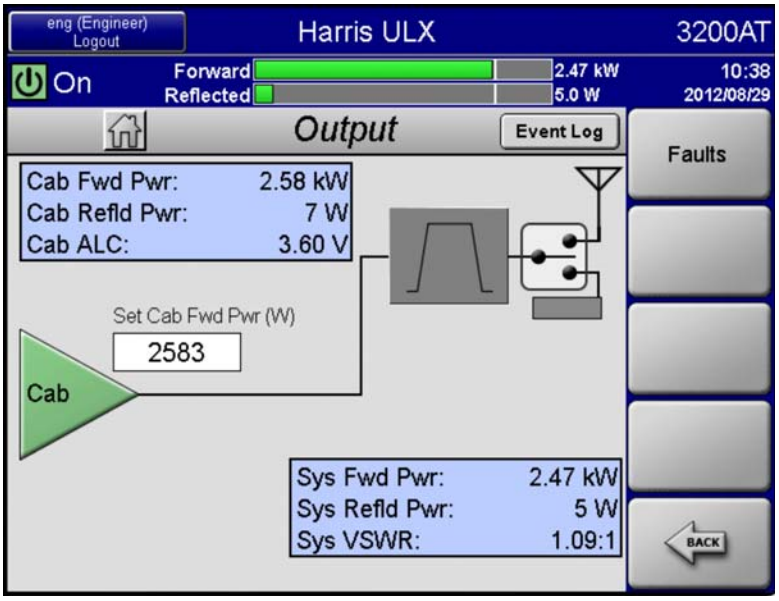

Figure 2-16 Output Screen

STEP 9 **Slowly bring up the transmitter power, by pressing the Raise button on front panel, to the nominal value, as indicated by the Cab Fwd Pwr value and by mesurement using an external power meter.** Monitor the cabinet forward and reflected powers as power increases. A high reflected power level (> 4%) is indicative of a defective trasnmission line connection, test load or other problem. Stop increasing power and begin troubleshooting if reflected levels are high.

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STEP 10 **Adjust cabinet phasing (in multi-cabinet systems) to reduce power into the cabinet combiner reject loads**. Inter-cabinet phasing is accomplished via the GUI (navigate to the Home>Output>Phase screen) to adjust the preamplifier module phasing in each cabinet relative to the other cabinets to reduce power to common reject loads.

STEP 11 Verify that the transmitter meter readings are close to the factory test data meter readings, especially all of the PA current and voltage readings.

Note

Rebias of the FETs in the PA modules is not required in ULX transmitters. They have been pretested at the factory to minimize drift.

STEP 12 **Verify power output (cabinet and system level) on GUI corresponds with the external power meter.** If there is a discrepancy, perform the power calibration procedures "5.9 Analog Power Calibrations" on page 5-12 or "5.10 Digital Power Calibrations" on page 5-21 in this manual.

STEP 13 End of procedure.

2.18 Customer I/O Board

The customer I/O board is located at the top of the main cabinet. Table 2-17 shows the board and also lists the connector names and numbers.

2.18.1 Parallel Remote Control Connections

Once proper operation of the transmitter has been established, remote control connections can be made. The following tables list the connectors and their corresponding signal names and functions.

Note

The Customer I/O board connections can be found at the top of the transmitter near the front. See Figure 2-17 for connector locations.

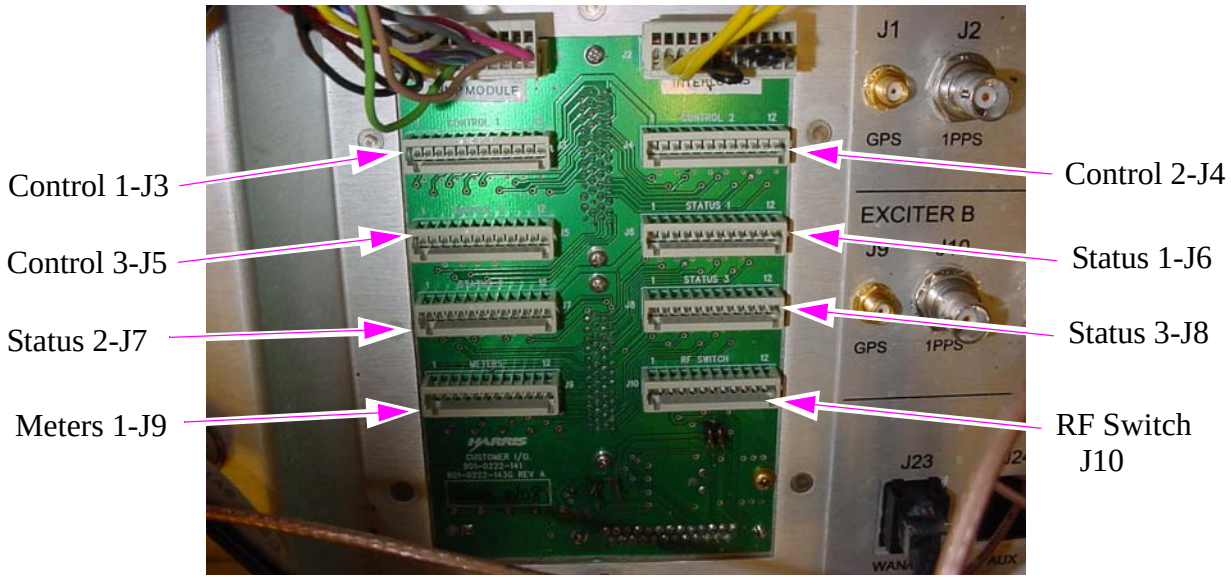

Figure 2-17 Parallel Remote Control Connections

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External Parallel remote control units can interface at the Customer I/O Board at the top of the cabinet. J13 through J17 are for remote Control, Status and Analogue readings. The connectors are organized as follows:

- J3, J4 and J5 - Remote Transmitter Control Functions
- J6, J7 and J8 - Remote Status Outputs
- J9 - Remote Analogue Metering Outputs

Note

The forward slash (/) in front of a signal name means active low. The signal named "/INPUT 1" for example is activated by bringing that input low. Signal names without the forward slash are considered active high. This convention is used throughout the schematics.

2.18.2 Transmitter Control Functions J3, J4 and J5

All control inputs use opto-isolators for surge protection. The opto-isolators are powered by an internal +5Vdc from an isolation protection circuit.

All transmitter control functions (except Remote RF Mute, RF Switch Position A and RF Switch Position B, which are active LOW or HIGH level input states) are momentary ground switching and require the remote control equipment to sink at least 15mA to activate the function. The pinouts of J3, J4 and J5 are listed in Table 2-12.

Table 2-12 J3, J4 & J5, Customer I/O Board, Remote Control Connectors

Connector and pin #	Function	Command Type and Polarity
J3-1	GROUND	
J3-2	Transmitter ON	Pulsed LOW
J3-3	Transmitter OFF	Pulsed LOW
J3-4	RAISE Power	Pulsed LOW
J3-5	LOWER Power	Pulsed LOW
J3-6		
J3-7	GROUND	
J3-8	Exciter A Select	Pulsed LOW
J3-9	Exciter B Select	Pulsed LOW
J3-10	Exciter Auto Select	Pulsed LOW
J3-11	Exciter Manual Select	Pulsed LOW
J3-12	GROUND	
J4-1	GROUND	
J4-2	IPA A Select	Pulsed LOW
J4-3	IPA B Select	Pulsed LOW
J4-4	IPA AUTO Select	Pulsed LOW
J4-5	IPA MANUAL Select	Pulsed LOW
J4-6	GROUND	GNDA
J4-7	Pump Switch Command	Pulsed LOW
J4-8	SPARE	
J4-9	Pump Auto Select	Pulsed LOW
J4-10	Pump Manual Select	Pulsed LOW
J4-11	GROUND	GNDA
J4-12	GROUND	GNDA

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Table 2-12 J3, J4 & J5, Customer I/O Board, Remote Control Connectors

Connector and pin #	Function	Command Type and Polarity
J5-1		
J5-2	Power Control Auto Select	Pulsed LOW
J5-3	Power Control Manual Select	Pulsed LOW
J5-4	GROUND	
J5-5	RF Switch A Select	Pulsed LOW
J5-6	RF Switch B Select	Pulsed LOW
J5-7	GROUND	
J5-8	NC	
J5-9	NC	
J5-10	NC	
J5-11	NC	
J5-12	NC	

2.18.3 Remote Status Outputs J6, J7& J8

All of the remote status outputs are open collector and will sink 100mA at up to +24Vdc to provide an indication status is active. The pull up supply voltage for the status indications can be supplied via J6, J7 & J8 or can be supplied by an external voltage source. The status output connections are listed in Table 2-13

.

Table 2-13 J6, J7 & J8 Customer I/O Board, Remote Status Outputs

Connector and pin #	Status Output	Status Type and Polarity
J6-1	GROUND	
J6-2	Transmitter OFF/ON Status	L=ON H=OFF
J6-3	Exciter A/B Active Status	L= B ON H= A ON
J6-4	Exciter AUTO/MANUAL Status	L= AUTO H= MANUAL
J6-5	GROUND	
J6-6	IPA A/B Active Status	L= B ON H= A ON
J6-7	IPA AUTO/MANUAL Status	L= AUTO H= MANUAL
J6-8	GROUND	
J6-9	Pump A/B Active Status	L= A ON H= B ON
J6-10	Pump AUTO/MANUAL Status	L= AUTO H= MANUAL
J6-11	GROUND	
J6-12	GROUND	
J7-1	GROUND	
J7-2	Remote Control ENABLED/DISABLED Status	L = Remote ENABLED H = Remote DISABLED

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Table 2-13 J6, J7 & J8 Customer I/O Board, Remote Status Outputs

Connector and pin #	Status Output	Status Type and Polarity
J7-3	RF Switch A/B Active Status	L= B ON H= A ON
J7-4	Power Control AUTO/MANUAL	L= AUTO H= MANUAL
J7-5	GROUND	
J7-6	RF MUTE ON/OFF	L= RF MUTE ON H= RF MUTE OFF
J7-7	VSWR FOLDBACK ON/OFF	L= ON H= OFF
J7-8	GROUND	
J7-9	VSWR FAULT	L=FAULT H= OK
J7-10	Transmitter Faulted OFF	L= Fault OFF H= OK
J7-11	GROUND	
J7-12	GROUND	
J8-1	GROUND	
J8-2	Exciter Fault	L=FAULT H= OK
J8-3	PA Fault	L=FAULT H= OK
J8-4	IPA Fault	L=FAULT H= OK
J8-5		
J8-6	Cooling Fault	L=FAULT H= OK
J8-7	Power Supply Fault	L=FAULT H= OK
J8-8		
J8-9	Summary Fault	L=FAULT H= OK
J8-10	Customer supplied isolated voltage for digital output opto-couplers and pull-ups	JP1 in the TCU customer I/O card must be set correctly to use this output.
J8-11	Customer supplied isolated voltage for digital output opto-couplers and pull-ups	JP1 in the TCU customer I/O card must be set correctly to use this output.
J8-12	GROUND	

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2.18.4 Remote Power Metering, J9

Each analog metering output will provide 0 - 4.096Vdc output into a 400 ohm load (where 3Vdc = full scale). The connections for J9 are listed in Table 2-14.

Table 2-14 J19, External I/O Board, Remote Power Metering

Connection	Metered Parameter
J9-1	System Forward Power
J9-2	System Reflected Power
J9-3	Ground
J9-4	Cabinet Forward Power
J9-5	Cabinet Reflected Power
J9-6	Ground
J9-7	IPA A Forward Power
J9-8	IPA B Forward Power
J9-9	Ground
J9-10	SPARE1
J9-11	SPARE2
J9-12	Ground

2.18.5 External RF Switch

The external RF switch connector is a 12 pin connector provided to allow control of motorized switch that is external to the transmitter. The connections for J10 are listed in Table 2-15.

Table 2-15 External RF Switch J10

Connection	Metered Parameter
J10-1	Switch Common
J10-2	Ground
J10-3	RF Switch Position A Select
J10-4	RF Switch Position B Select
J10-5	Ground
J10-6	RF Switch Status A
J10-7	RF Switch Status B
J10-8	Ground
J10-9	Ground
J10-10	NC
J10-11	NC
J10-12	NC

2.18.6 Emergency Off Jumpers-JP4 &JP5

Later versions of ULX transmitters are configured with JP4 and JP5 jumpers which are located inside the cabinet on the underside of the customer I/O board, between top connectors J2 and J4. JP4 and JP5 jumpers are configured differently depending on the presence of optional emergency off buttons on the front and rear of the transmitter. If the transmitter is not equipped with emergency off buttons, JP4 and JP5 are configured from 2-3 (bypass). If a front emergency off button is used then JP4 is placed in the 1-2 (normal) position. If a rear emergency off button is used then JP5 is placed in the 1-2 (normal) position. See JP4 and JP5 location in Figure 2-18

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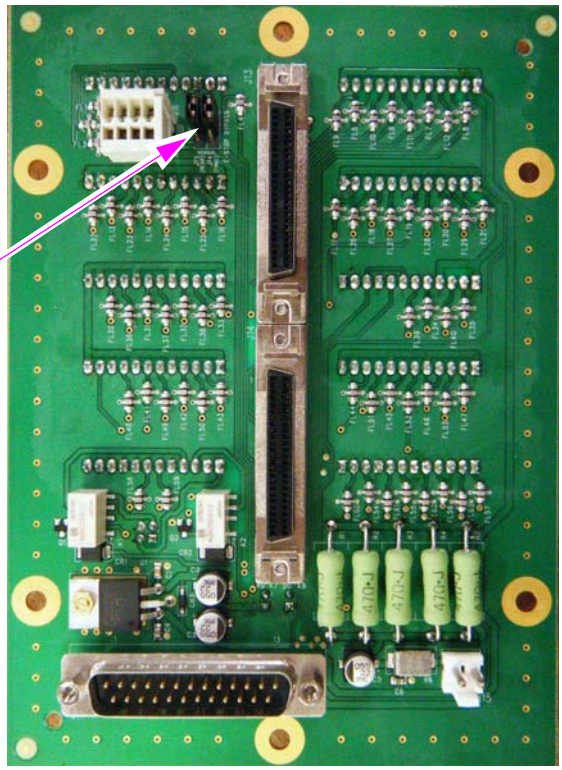

Figure 2-18 Underside of Customer I/O Board

2.19 Install Battery in TCU PCM Card

When the transmitter is ready for operation install the real time clock battery on the TCU PCM card. This battery maintains the time and date when the transmitter loses AC power. Refer to "5.14.5 Changing the PCM Card Battery" on page 5-39. Depending on shipping restrictions the battery can be found inside a plastic bag that may also contain battery installation instructions.

2.20 Connecting to the ULX via IP / Ethernet

The ULX transmitter may be accessed by a computer via Ethernet for setup, operation, and software downloads. This connection is typically made to the TCU PCM-2 card or at the Ethernet connector located at the top of the transmitter.

Note

As of this printing, Harris Broadcast recommends Firefox web browser for use with this transmitter.

2.20.1 TCU Access via Ethernet

The TCU serves a main gateway to the ULX transmitter. The web pages for the individual M2X exciters are available via the main TCU Ethernet connection as submenus on the TCU home screen. The main connection to the TCU is via a rear RJ45 port that is typically brought to the top of the transmitter rack. The TCU does not have a built-in DHCP server for establishing 1:1 PC connections. It must either automatically acquire an IP address from a DHCP server on an existing network or have a static IP address manually assigned on the appropriate screen of its GUI interface.

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2.20.1.1 TCU Ethernet Access via PCM Card RJ45 Connector

TCUs equipped with later version PCM-2 cards (post-March 2012 units) have two front panel RJ45 Ethernet connectors. The lower connector is used for connection from the PCM card, via a small CAT5 jumper, to the TCU front panel touch screen mini-PC. The second (upper) RJ45 connector is available and can be connected via Ethernet cable to a local computer. This connection does not require a crossover cable and typically has an IP address of 192.168.2.100.

In order to use the PCM card RJ45 connectors for access the local computer must be setup with static IP address that is in the 192.168.2.xx family.

2.20.1.2 TCU Ethernet Access Procedure

STEP 1 **Connect an Ethernet cable between the RJ45 connector at the top of the transmitter rack and the existing network.**

STEP 2 **The TCU will automatically obtain an IP address if DHCP has been enabled on both the TCU and the network.** Otherwise, manually set an appropriate static IP address via the Home > System > Service > Network menu on the front panel touch screen and connect computer directly to Ethernet port on top of computer.

STEP 3 **Type the TCU IP address http://nnn.nnn.nnn.nnn into the address bar of a web browser to contact the TCU, where nnn.nnn.nnn.nnn is the address appearing at the bottom of the Home screen or can be found at Home > System > Service > Network on the front panel touch screen.**

Some network switches utilizing secure connections will require the MAC address to be given to the switch to allow traffic to pass to and from it. The MAC address can be found at the top of the Home > System > Service > Network page.

STEP 4 **When prompted, log in using username and password. TCUs that contain the PCM-2 card (post March 2012) must have usernames and password set up by the user locally prior to establishing a remote web browser connection.** The username and password setup procedure is outlined in Section 3.2.2 on page 3-2

STEP 5 **The TCU web GUI is now displayed and can be navigated as needed.**

STEP 6 **Procedure complete.**

2.21 Connecting to the ULX via SNMP

The ULX transmitter family supports monitoring and alarming functionality via SNMP (Simple Network Management Protocol). Basic control of the equipment is possible after activation in the equipment. SNMP versions V1 and V2c and V3 are implemented.

This section assumes a good working knowledge of networking and SNMP connectivity. The information contained here is not meant to teach networking or how to setup/operate a network manager application, but merely provide the information necessary for a network administrator to connect and operate the ULX transmitter using the SNMP connection.

2.21.1 SNMP Configuration

SNMP connection to the TCU is described in Section 3.9.3.3.1 on page 3-29.

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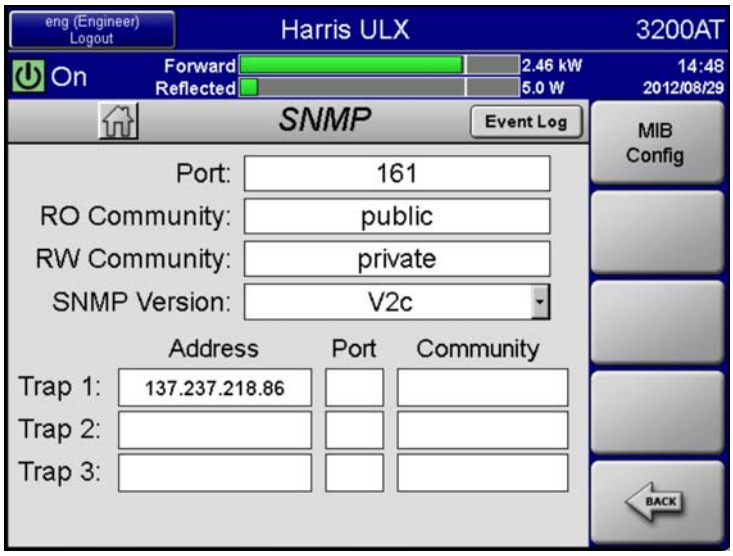

Figure 2-19 LPU SNMP Setup Screen

The SNMP setup screen allows location setting for connection identification, destination IP address for trap messages, R/W community, Enable/Disable of Set commands, Port, selection of V1 or V2 traps and deletion of IP addresses.

2.21.2 Supported MIBs

As of this printing, the Harris Broadcast ULX transmitter can serve out three different MIBs:

- Harris Broadcast transmitter base MIB (basic functionality for all transmitters)
- IRT DVB Single Transmitter MIB
- IRT DAB Single Transmitter MIB

2.21.3 Harris Broadcast Base MIB Description

The Harris Broadcast base MIB is usable in all NMS (Network Management Systems) and is provided in text-format. The base MIB has the advantage of being common to many different equipment types, thus allowing many different Harris Broadcast devices to be monitored once the MIB is imported to the NMS. Refer to Section 3.9.3.3.2 on page 3-30 to view MIB setup screen.

Once an alarm has been signaled in SNMP, an Internet browser can be opened in the NMS for full monitoring and control capabilities via the HTTP web remote.

Note

TV transmitter MIBs are available on the Customer Portal. Register for access at http://ecustomer.broadcast.harris.com/ecustomer_enu/ then navigate to eService Documentation>Television Transmission>TV-Other>SNMP-MIBS to download the applicable files.

2.21.4 Shortcuts

Following shortcuts are used in the MIB descriptions:

- OS :Octet String
- TT :Time Tick
- OID : Object Identifier
- G32 : Gauge 32
- TRV : TRuth Value
- ENU : ENUmerations
- RO : Read Only
- RW :Read Write

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2.21.5Harris Broadcast SMI (Structure of Managed Information)

Harris Broadcast Transmission SMI

Harris Broadcast Transmitters branch OID: 1.3.6.1.4.1.290.9.2.1
iso(1).org(3).dod(6).internet(1).private(4).enterprises(1).harris(290).bcd2(9).transmission(2)

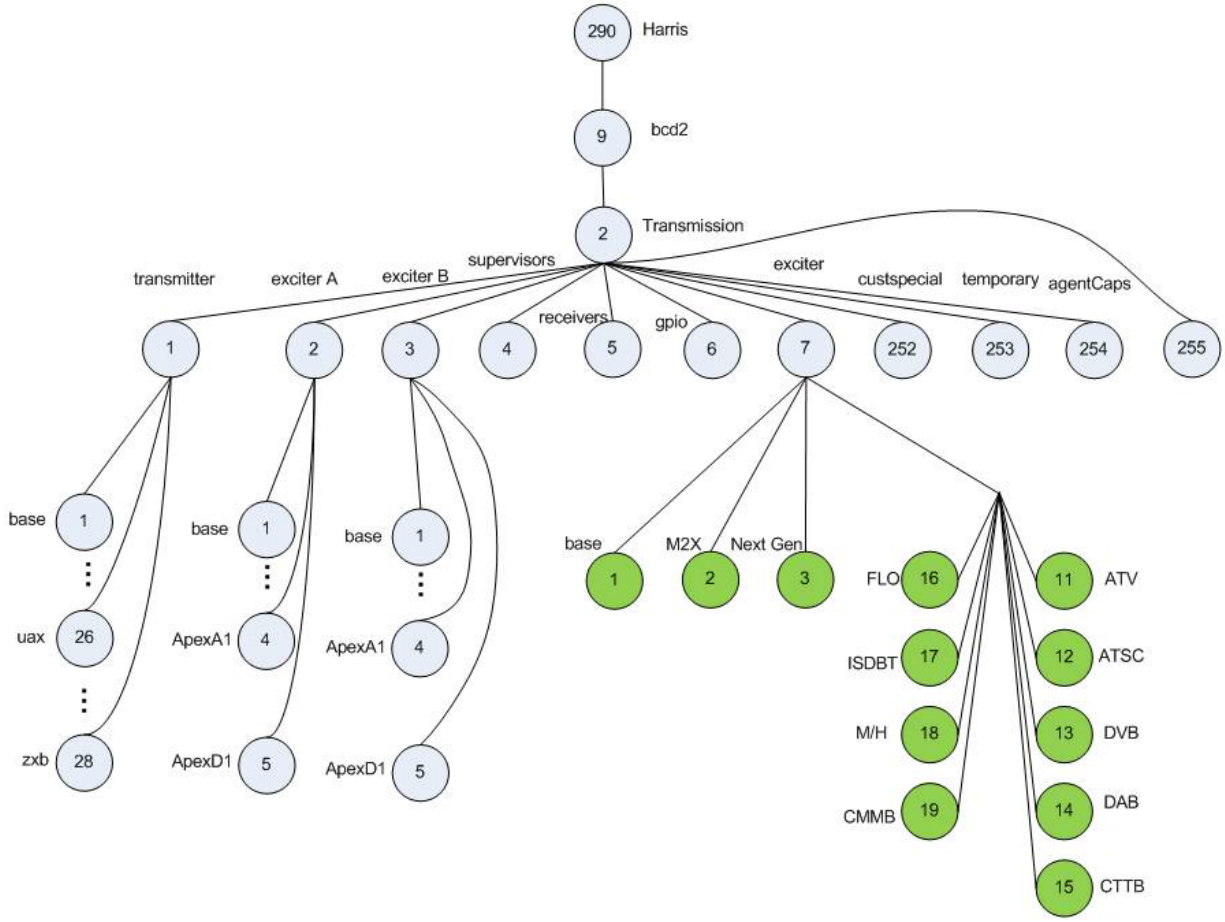

Figure 2-20 Harris Broadcast SMI Block Diagram

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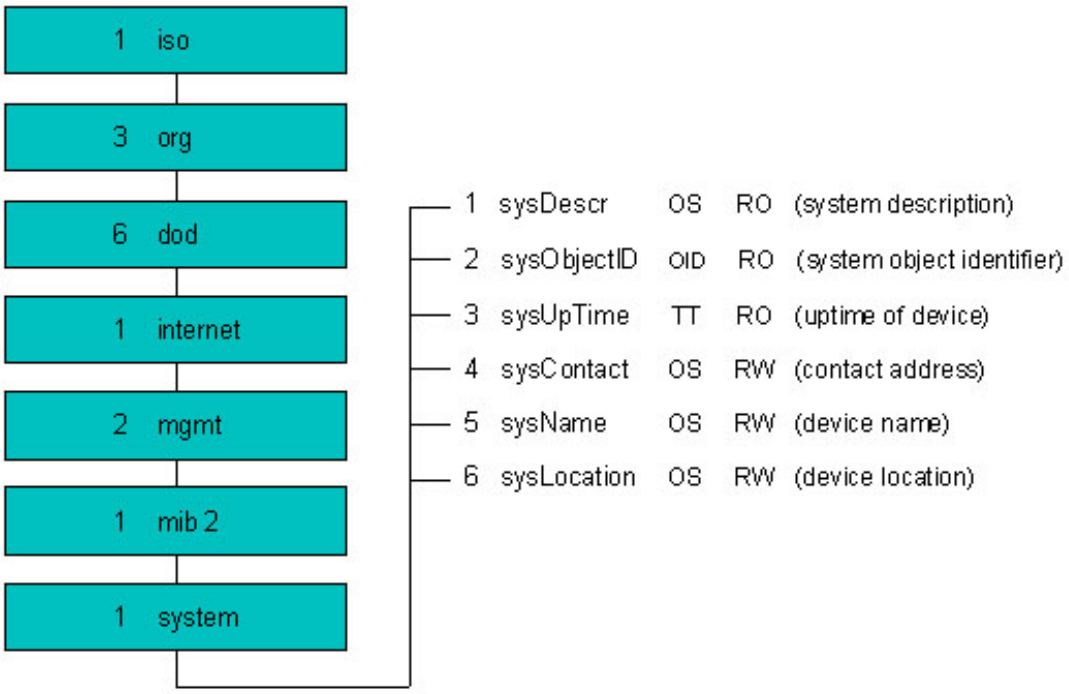
1 iso
3 org
6 dod
1 internet
2 mgmt
1 mib 2
1 system
1 sysDescr OS RO (system description)
2 sysObjectID OID RO (system object identifier)
3 sysUpTime TT RO (uptime of device)
4 sysContact OS RW (contact address)
5 sysName OS RW (device name)
6 sysLocation OS RW (device location)

Figure 2-21 MIB 2 Description

Section-3 Operation 3

3.1 Introduction

This section gives detailed operational information for the Maxiva ULX Series Solid-State UHF TV transmitter. Information will pertain mostly to the operation and navigation of the TCU graphical user interface (GUI) touchscreen display.

Note

Operation of the M2X exciter is covered in a separate manuals which ships with the transmitter.

3.2 Operating the Transmitter Control Unit (TCU)

The front panel user interface is a panel PC touchscreen display. This touchscreen display uses software buttons to control the transmitter. Hardware buttons for the primary transmitter functions such as ON/OFF, RAISE/LOWER and Remote Enable/Disable are provided on the front panel next to the display as shown in Figure 3-1.

Note

When transmitter is turned off using the OFF button under normal conditions, the pump module pump will continue to operate for several minutes before shutting down. If immediate pump shutdown is desired then pump module can be turned off at the cooling control panel (on the pump module).

The TCU does not have an AC mains ON/OFF switch. Mains power is applied to the unit by plugging two energized power cords into the AC connectors (two, IEC C15) on the rear of the TCU chassis. The TCU will operate over a voltage range of 90- 240VAC, 47-63 Hz, auto ranging.

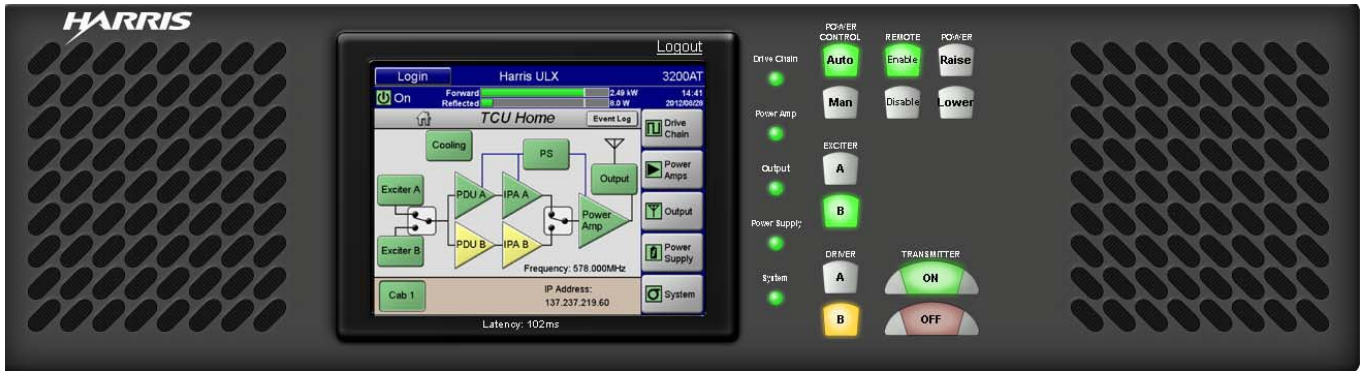

Figure 3-1 Transmitter Control Unit (TCU)

Note

A similar set of GUI screens is available via web browser with an ethernet network connection on the customer I/O panel at the top of the cabinet.

3.2.1 Basic Operating Procedures

The TCU can be operated from the front panel PC touchscreen and control pushbuttons, or by using the web browser interface, which is accessed via computer. Web browser interface via computer is explained in Section 2.20,

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on page 2-38. Before accessing the transmitter via remote web browser interface the factory default password must be changed locally using the front panel PC touchscreen.

3.2.2 TCU - Initial Login & Passwords

There are three TCU password levels:

- **Administrator:** Allows one user access to change passwords.
- **Engineer:** Two users can access the TCU each using a different Engineer level password. Engineer level allows full access to the transmitter to view screens and make changes to settings.
- **Guest:** Multiple guest level users can access the TCU to view all screens.Guest users can make no changes. No username or password entry is required.

Note

Transmitters that contain a TCU require setup of TCU passwords prior to the use of the remote web browser:

STEP 1 **With AC power applied to the transmitter components, touch the panel PC screen to activate it.** The TCU Home screen will display as shown in Figure 3-9 on page 3-11.

STEP 2 **Press the Login button in the upper left corner of the TCU Home screen.** This will open the Login screen shown in Figure 3-5 on page 3-6.

STEP 3 **Login as Administrator by entering the username *admin* and the password *admin*.** The screen shown on the left in Figure 3-2 will open.

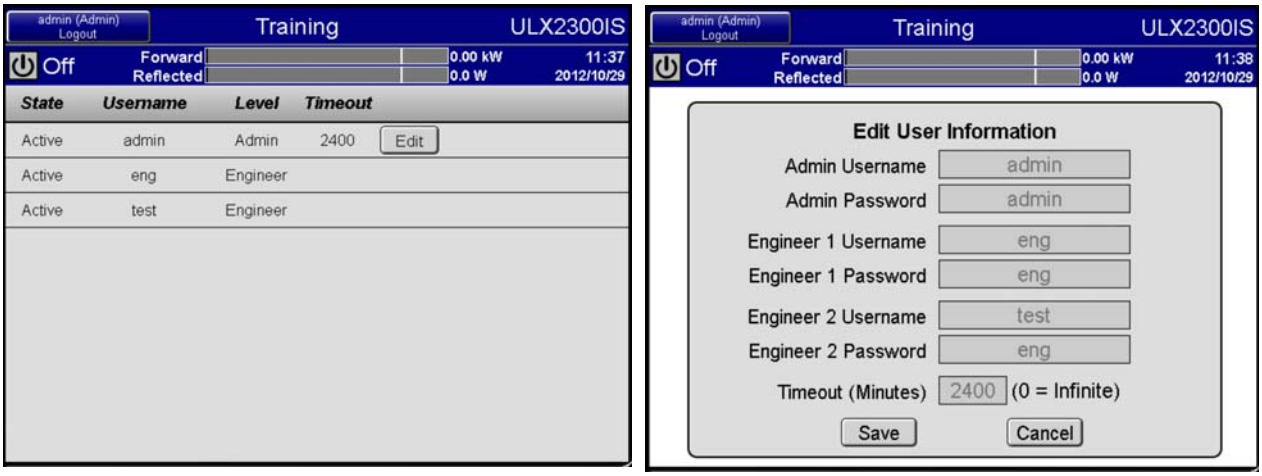

Figure 3-2 TCU Admin Screens

STEP 4 **Press the Edit button to display the screen shown on the right in Figure 3-2.**

STEP 5 **Press the Admin Password box and touchscreen keyboard will open allowing entry of a new admin password.** Enter the desired admin level password and press done. Once changed the new admin level password will allow the administrator to change passwords remotely.

Note

The Admin level default username admin can not be changed.

STEP 6 **Press the appropriate boxes to set the Engineer 1 and 2 usernames and passwords.**

STEP 7 **Record the newly selected usernames and passwords for future reference.** Should the admin password be forgotten or lost contact Harris technical support to obtain assistance. The contact information is provided on page iii.

STEP 8 **Enter the desired Timeout by pressing the Timeout window and entering the value in minutes** . Entering 0 will keep the user logged in until the browser closes or times out. If the session ends without logout the user will stay logged in for five additional minutes before being logged out.

Note

TCU login at the local GUI screen is required following each access to the M2X screens.

STEP 9 **Press the Save button on the lower part of the screen to save the newly entered values.**

STEP 10 **Press the Logout button in the upper left hand corner of the screen.**

The web browser interface can now be used remotely if the TCU is connected to a network, or by connecting a computer to the RJ45 Ethernet port on the top of the transmitter cabinet. Simply enter the IP address of the TCU into the web browser. The TCU IP address can be found (or set) by navigating to the TCU Home>Service>Network screen on the panel PC.

STEP 11 **End of procedure.**

3.2.3 Hardware Control Buttons &LEDs

The TCU hardware buttons provide immediate control of six transmitter functions.

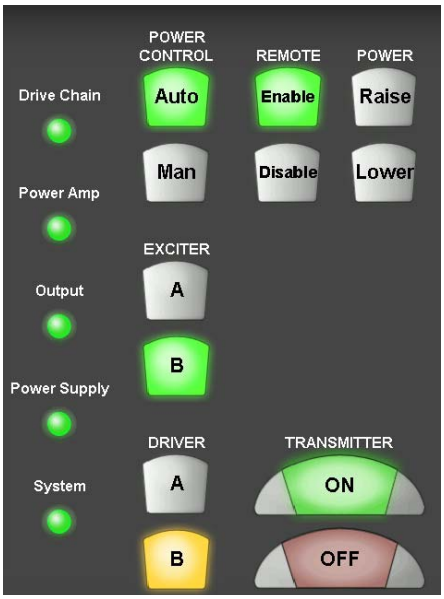

Figure 3-3 TCU Hardware Control Pushbuttons

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Table 3-1 TCU Control Buttons

Button	States	Explanation
Power Control	Auto/Manual	Auto: Automatic power level control activated. The transmitter RF output power is held to the level established by the FWD PWR REF setting. Manual: The power level can be manually raised or lower using the Power Raise or Power Lower buttons.
Remote	Enable/Disable	Enables or disables remote control of the transmitter. Enable: The transmitter system can be remotely controlled by either the user parallel interface or the remote web interface.3 Disable: The transmitter will only respond to local commands issued from the various front panel controls.
Power	Raise/Lower	Pressing raise will increase RF power output. Lower decreases power output. ***Caution:*** *There may be a slight lag in system power level response time.* Holding buttons in may cause undesired power overshoots.
Exciter	A/B	Selects which M2X exciter is connected to the high power amplifier stages and ultimately the antenna or system load. The non-selected (reserve) exciter is connected to a small RF dummy load.
Driver	Auto/Manual	Auto: Automatic driver switchover is enabled. The system will select the reserve predriver/IPA module in the event of the failure of the main predriver/IPA module. Manual: Automatic predriver/IPA module switchover is disabled. The system will not automatically select the reserve predriver/IPA module in the event of the failure of the main LPU.
Transmitter	ON/OFF	Switches transmitter RF output on or off. Built-in switch LEDs provide feedback as to ON/OFF status of transmitter system. ON button is lit green when transmitter system is switched on. OFF button is lit red when transmitter system is switched off.

Refer to TCU hardware control buttons in Figure 3-3. On the left of the hardware control buttons are five LEDs that provide subsystem status information. The subsystems are: Drive Chain, Power Amp, Output, Power Supply, System. The Status LEDs light amber (yellow) for a warning and red for a fault condition in the transmitter subsystems. The LEDs light green if the sub-system in question is normal (without faults). This provides quick sub-system status information without having to be familiar with a menu structure. The LEDs are de sc i bed in Table 3-2 which follows.

Table 3-2 TCU Status LEDs

Status Indicator	States	Summary Status
Drive Chain	Green/Amber/Red	This is a summary of the following: 1. M2X exciter A and Predriver/ IPA A Status (OK, Warning, Fault) 2. M2X exciter B and Predriver/ IPA B Status (OK, Warning, Fault) 3. Active M2X Exciter or Predriver/ IPA Summary Fault Status (OK, Fault) 4. M2X exciter A Mute Status (Warning if muted) 5. M2X exciter B Mute Status (Warning if muted).
Power Amp	Red/Amber/Green	This is a summary status of the Power amplifier modules, (OK, Warning, Fault).
Output	Red/Amber/Green	This is a summary status of the transmitter power output, (OK, Warning, Fault).
Power Supply	Red/Green	This is a summary status of the TCU power supplies.
System	Red/Amber/Green	System – This is a summary status for the following: 1. Exciter A System Status (OK, Warning, or Fault) 2. Exciter B System Status (OK, Warning, or Fault). 3. TCU Communication fault to a board on the TCU backplane in slots 1 - 6 4. TCU Front Panel Board communication loss 5. TCU On board MCM A/D D/A Loopback fault 6. TCU Board Configuration Error (Board is in the wrong slot number) 7. TCU Major Fault (The transmitter will not allow the ON command. Possible reason: System Safety Interlock fault) 8. TCU Communications loss to a board on the TCU backplane slots 1-6 9. TCU System Safety Interlock Open (Possible cause: Emergency off activated)

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3.2.4 TCU Cards - Resets and Memory Cards

Figure 3-4 TCU Front Panel Lowered

There are two power supply cards located on the left side of the TCU chassis and seven or eight cards to the right side of the PSs. The boards are numbered 1 through 8, right to left. The 1st board (furthest to the right) is the MCM (main control module), the 2nd board is the PCM (processor control module), the 3rd board is the RF detector, the 4th is the customer I/O board, the 5th is the exciter switcher, 6th is PS monitor the 7th & 8th are PA interface (digital I/O) boards. The 8th card (PA interface) is only present in transmitters with more than 8 PA modules. The two power supplies on the left are redundant.

To gain access to the internal boards, simply pull outward and then down on the front of the TCU panel. The openings on the left and right of the TCU front panel can be used as handles.

Should the GUI screen go gray, black or yellow or give a communications warning, a PCM reset may be required. To reset the PCM, pull down the GUI front panel exposing the circuit cards in the TCU chassis as shown in Figure 3-4. The second board from the right is the PCM board. The PCM-2 reset button is located toward the center of the board (an inch from the front edge) and faces the RF detector board. Use a finger tip, pencil or pen to gently depress the small button.

Note

It will take approximately 20 seconds for the PCM card to reset. If the transmitter is on the air, resetting the PCM or panel PC will NOT affect transmitter RF output. Remote communications will be disrupted during the reboot.

A PCM software restart or hard-reset can also be accomplished by pressing the GUI software buttons TCU HOME> SYSTEM> SERVICE>SOFTWARE UPDATE followed by selection of the Reset tab and then either the Restart or Reboot buttons.The screen and buttons are shown in Figure 3-38 on page 3-31.

Just in front of the PCM-2 restart button is a micro SD card, 2GB which serves as a hard drive for the computer daughter board on the PCM-2 card. The computer image and versions of PCM-2 software are stored on this card.

There is another reset button near the bottom of the MCM board (farthest board to the right). This reset button resets all TCU cards except for the PCM. The MCM reset results in a control system reset. The MCM reset will take the transmitter off the air for a few seconds.

Just above the MCM reset button is a removable flash memory card containing control system software. This card should be installed in any replacement MCM card that is installed. The card can be removed while the transmitter is on-air but reinsertion of the card (in PCM-1 systems) will cause the transmitter to go off-air for a few seconds as the TCU control system reboots. Systems that use PCM-2 cards will not go off air when the MCM flash memory card is inserted.

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3.3 Graphical User Interface (GUI)

The GUI ("Gooey") was designed to provide an intuitive interface into the transmitter control system. The GUI is accessible locally via the TCU front touchscreen panel or remotely via web browser interface to the TCU. Once you become familiar with content, finding information is simply a matter of following the screens to the desired section of the transmitter. Menu Trees of all available screens are given in Figure 3-7 on page 3-9.

With REMOTE *Enabled* locally via hardware control buttons, and after Login, navigation and control is accomplished via the web browser using mouse entries. Web browser screens have active areas which are indicated by the hand icon which appears when the mouse is brought to rest over an active icon. Upon selection by left mouse click on an icon an initial screen is presented. Further navigation through different menus is accomplished by clicking on the icons or software buttons along the right edge of the screen. The icons and buttons change with each screen selected.

Note

The local (front panel) TCU GUI LCD screen and control buttons cannot be used to update LPU software, it is updated via remote web browser.

Note

Harris recommends the Firefox browser. In Firefox, screens can be enlarged by pressing <Ctrl> and <+> simultaneously. Screen sizes are reduced by pressing <Ctrl> and <-> simultaneously.

Note

If REMOTE is Disabled on the hardware front panel, navigation and monitoring via web browser is still possible but transmitter control is not.

3.3.1 Connection Via Web Interface

Refer to Section 2.20, on page 2-38. The web browser interface can be used either remotely if the transmitter is connected to a network or locally by connecting a computer to the RJ45 Ethernet port on the top of the cabinet or to the PCM card port. Simply enter the transmitter's IP address into the web browser. Harris recommends the Firefox browser. The IP address can be found at the bottom of the home screen or by navigating via the touchscreen to the System > Service > Network screen on the LCD.

3.3.2 Web Browser Login Screens

Upon TCU web browser connection the TCU Home page will be displayed. The TCU login screen, Figure 3-5, can be opened by pressing the Login button in the upper left corner of the TCU Home page.

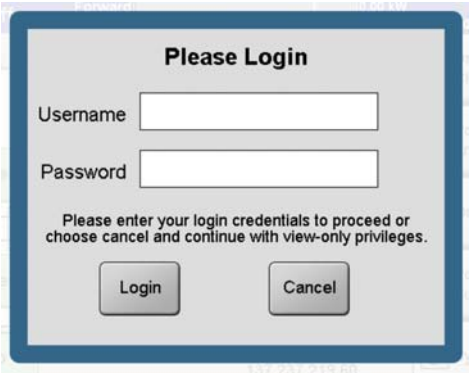

Figure 3-5 TCU Login Screen

Note

If Login screen with 'Cancel' options are displayed, the user may select Cancel to have Guest (view-only) privileges.

Table 3-3 Login Parameters TCU & LPU

Unit	Username	Password
TCU Administrator	admin	admin (default, must be set by user, see Section 3.2.2, on page 3-2).
TCU Engineer 1	Set by user.	Set by user.
TCU Engineer 2	Set by user.	Set by user.

TCUs allow for two simultaneous engineer level users. TCU usernames, passwords, and access time can be set and changed by Administrator login. See Section 3.2.2, TCU - Initial Login & Passwords, on page 3-2.

3.3.3 Global Status and Navigation

The top 2 sections of the touchscreen display (dark blue background) are considered global because they show up on all screens. The top line indicates the transmitter name and model number.

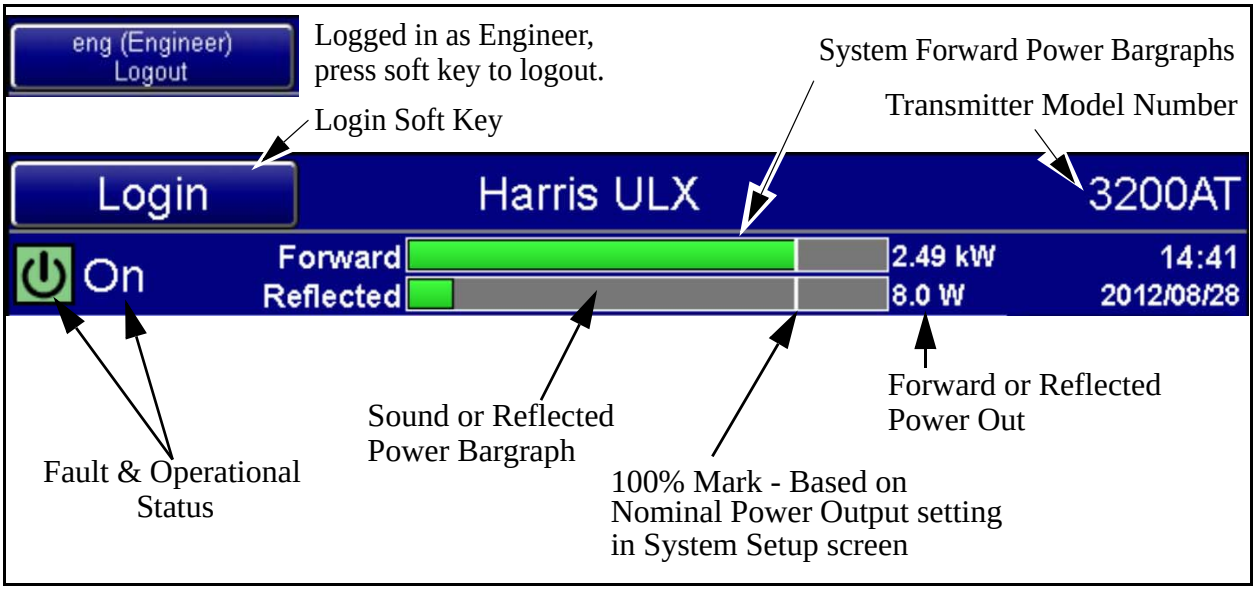

Figure 3-6 Global Display Header

The second line of the display has operational and status information including:

a. **ON**, **Standby**, **Fault OFF**, **ON/FB** (transmitter foldback), **PS MUTE**, and **RF MUTE** status indication.

- **ON:** Normal operating mode
- **Standby:** Transmitter turned off manually or remotely
- **Fault OFF:** Transmitter forced off due to fault condition
- **ON/FB:** Transmitter power folded back. Conditions causing the foldback may by temporary and could possibly be cleared by pressing the ON button. If, after pressing the ON button to reset the foldback, the ON/FB indication resumes the malfunction will need to be determined and the transmitter repaired (see Section 6 for fault log listings).
- **PS MUTE:** A temporary fault condition caused by a power supply related fault. If underlying fault clears, the mute condition will be lifted and the transmitter returned to normal operating mode. If the mute continues, the underlying fault will need to be determined and the transmitter repaired (see Section 6 for fault log listings).
- **RF MUTE:** A temporary fault condition caused by an RF related fault. If underlying fault clears, the mute condition will be lifted and the transmitter returned to normal operating mode. If the mute continues, the underlying fault will need to be determined and the transmitter repaired (see Section 6 for fault log listings).

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b. Transmitter Forward power output reading in numerical format (for multiple cabinet transmitters this would be a system power reading and not for a single cabinet). It is important to note that this is the power output after the filter.

c. Transmitter Forward power output reading in a bargraph format. The 100% mark is based on the nominal power level or TPO (Transmitter Power Output) entered into the configuration screen. The bargraph will also turn yellow if the power level is higher or lower (user sets values) than the nominal 100% level.

Note

Indications on the global display header in Figure 3-6 should be all green under normal (no fault) operating conditions. A yellow or red symbol or status indication on the global display header should be investigated by the station engineer.

3.3.4 GUI Menu Structures

Figure 3-7 lists the screens which can be accessed via the GUI. This tree may be helpful when learning to navigate the screens. The block on the left represents the Home (main) Screen. Sub screens can be accessed using one of the software buttons on the right side of the GUI Home Screen or the various sub screens which have software buttons on the right side.

Note

Multi-cabinet Maxiva series transmitters will require an extra button press at the top level menus to select the desired cabinet.

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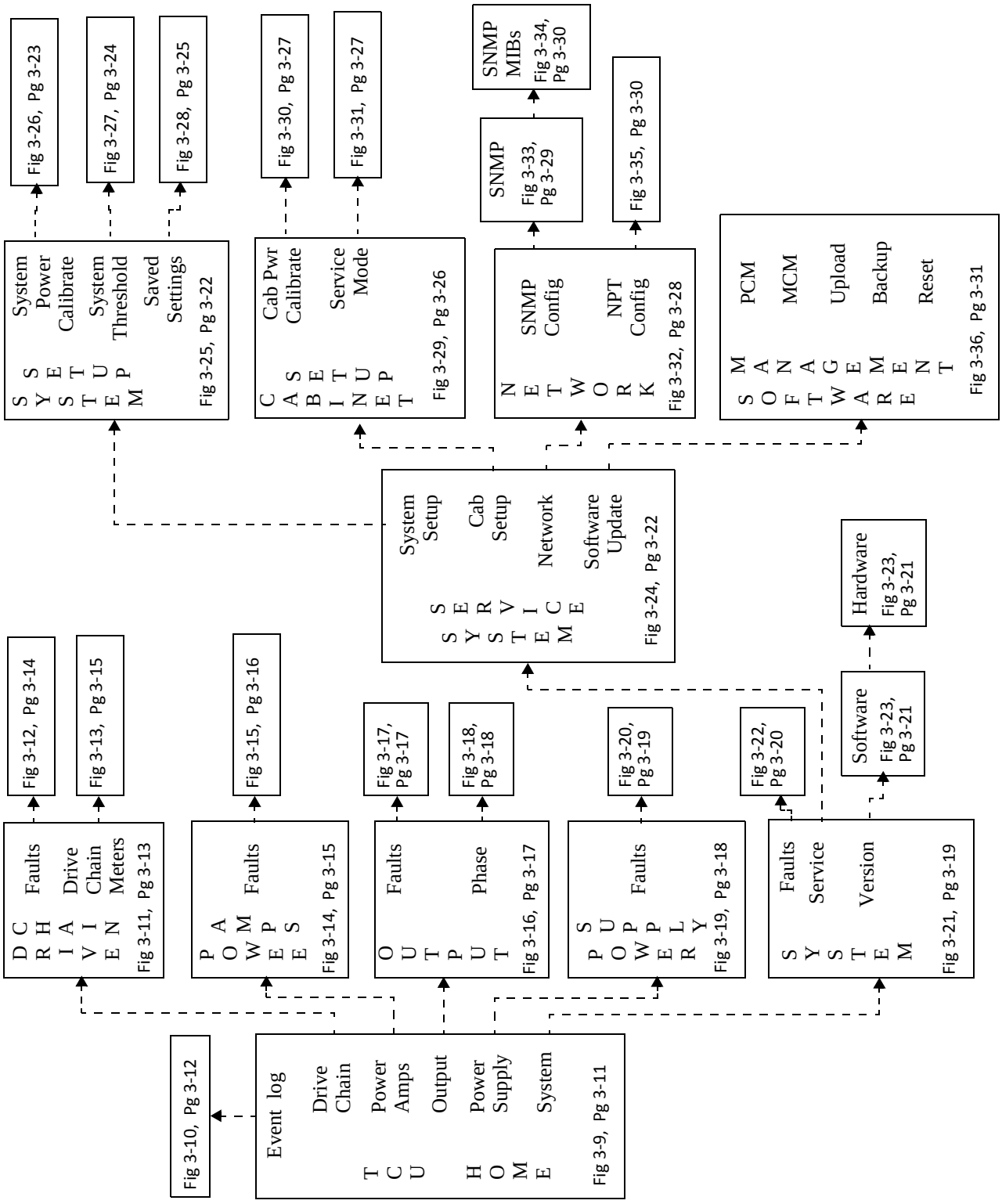

Figure 3-7 PCM2 GUI Menu Tree

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3.3.5 System Home Screen For Dual Cabinets

There are two home screens.

- Figure 3-8 is the System Home screen used for dual cabinet systems.
- Figure 3-9 is the TCU Home screen used for single cabinet systems.

The HOME icon (shown to the right) is a software button located in the upper left quadrant of most screens. The quickest way to access the HOME screen is to press the HOME icon on a screen.

If a submenu screen is displayed on the GUI (for example, see Figure 3-11), the lower right-hand button will typically be the back (arrow) button; use this back arrow button to go back one level. Multiple presses of the back arrow on submenu screens will end up at the TCU Home screen shown in Figure 3-9.

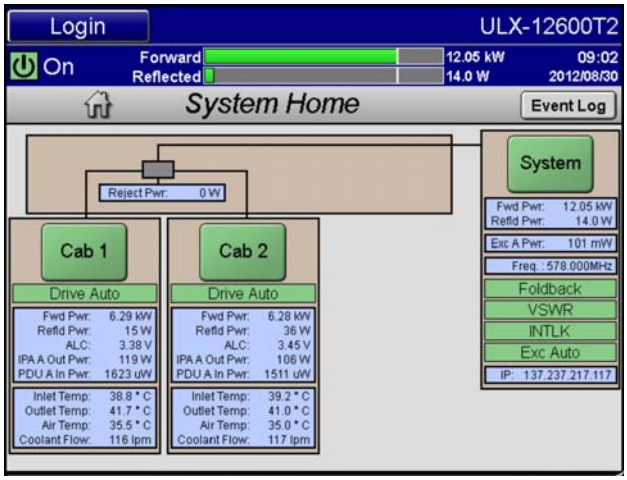


Figure 3-8 Dual Cabinet System Home Screen

In Figure 3-8, pressing the green Cab 1 or Cab 2 soft keys will navigate to the appropriate TCU home screen, see Figure 3-9. Pressing the green System soft key will navigate to the System screen shown in Figure 3-21.

3.3.6 Login and Logout

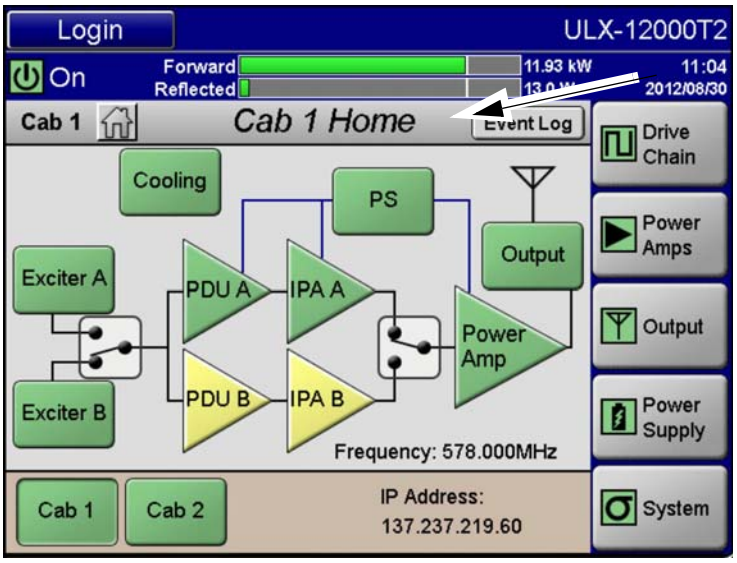
The Login soft key is located at the top left corner of each screen, see Figure 3-6.

For the administrator's login, the default Local and remote username and password is 'admin'. The administrator must log in locally and set the engineer's username and password. The administrator's password must be changed to allow remote change of administrator password and engineer level passwords and logins.

3.4 TCU Home Screen, Single or Dual Cabinets

The HOME screen shown in Figure 3-3 is the primary operator screen and the default single cabinet screen after boot up. The HOME screen contains the most important general operator information such as:

a. Cooling status
b. Power supply status
c. Drive chain selection (pre-driver and IPA status)
d. Amplifier status
e. System status



Event Log, Figure 3-10 on page 3-12

To Figure 3-11 on page 3-13

To Figure 3-14 on page 3-15

To Figure 3-16 on page 3-17

To Figure 3-19 on page 3-18

To Figure 3-21 on page 3-19

Figure 3-9 ULX-TCU Home Screen

The Home screen also has the global status and operation information at the top of the screen which shows the transmitter status, power output and any faults present.

There are five touchscreen navigation buttons on the right side of the GUI Home display. These buttons vary from screen to screen. The software menu buttons can also act as status indicators and turn red if a fault condition is detected.

There is a navigation button (shown to the right) to allow access to information specific to the PA cabinet. Pressing this button will take you to the Power Amp screen shown in Figure 3-14 on page 3-15.

This button is also a status indicator for the PA cabinet. It will change from green to red, if a problem is detected in that cabinet.

Similarly, pressing the exciter, PDU or IPA icons will take you to the main drive chain menu.

Table 3-4 TCU Status Indicators

Status Indicator	States	Summary Status
Drive Chain	Green/Amber/Red	This is a summary of the following: 1. A Drive Chain Status (OK, Warning, Fault) 2. B Drive Chain Status (OK, Warning, Fault) 3. Active Exciter Summary Fault Status (OK, Fault) 4. A Mute Status (Warning if muted) 5. B Mute Status (Warning if muted).
Power Amps	Red/Amber/Green	This is a summary status of the following: 1. Power Amps status (OK, Warning, Fault).
Output	Red/Amber/Green	This is a summary status of the following: 1. Output status (OK, Warning, Fault)
Power Supply	Red/Green	This is a summary status of the following: 1. Power Status (OK or Fault) 2. Power Supply Status (OK or Fault). 3. TC3-Phase In 4. MOV Bd, LVPS Status (OK or Fault)
System	Red/Amber/ Green/Gray	System – This is a summary status of the following: 1. Cooling System Status (OK or Fault) 2. Pump Control Status (OK or Fault) 3. TCU System Safety Interlock Open

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Note

To simplify the discussion of GUI navigation, the following sections describe the screens under the five main menu buttons located on the right side of the GUI TCU Home screen.

3.4.1 Event Log

An event log soft key is present at the top of each screen. The event log gives a list of transmitter and system events, warnings and faults in the order in which they occurred. It can hold up to 1,000 faults and then becomes a FIFO (First IN - First Out) memory buffer, with the **latest entry on top**. *Active* faults and warnings will be highlighted and cannot be reset. All other entries will be cleared when the CLR LOG (clear log) button is pressed. Use the scroll bar to view the entire list.

The TCU event log can be viewed in its entirety, printed, or exported by clicking on the web browser screen soft keys shown in Figure 3-10.

A listing of faults which may show up in this log, along with a brief explanation of each fault, is given in the following tables in Section 6, Diagnostics.

- Table 6-1, “Maxiva Drive Chain Fault List,” on page 6-3
- Table 6-2, “PA and IPA Module Fault List,” on page 6-4
- Table 6-3, “Power Supply Faults List,” on page 6-4
- Table 6-4, “Output Faults List,” on page 6-5
- Table 6-5, “System Faults List,” on page 6-6

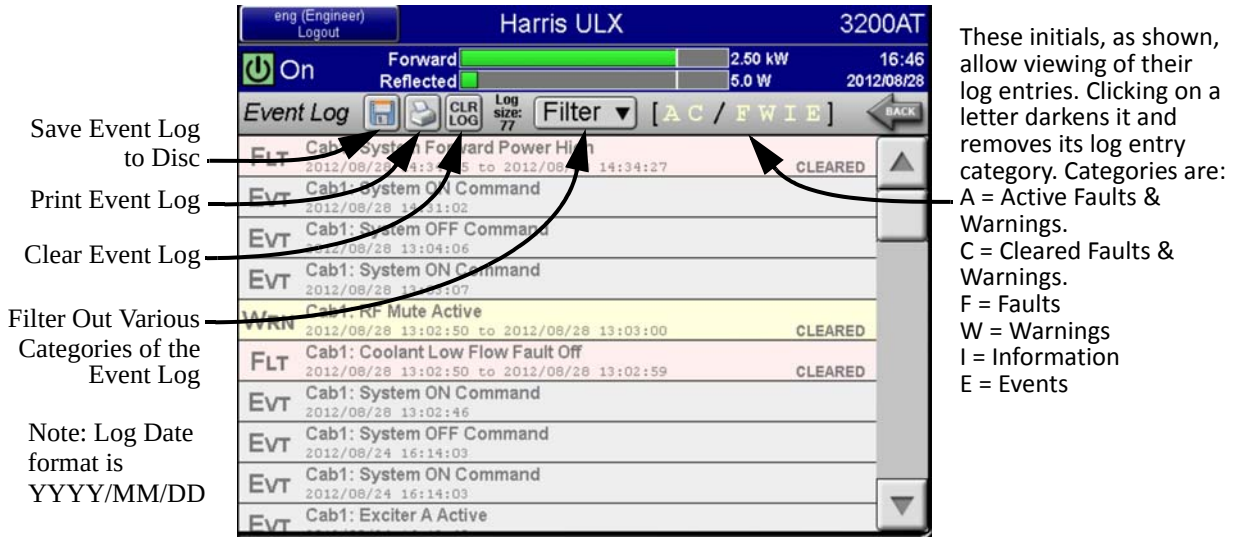

Figure 3-10 Event Log Screen

In Figure 3-10, the Filter soft key is easier to use when operating the transmitter from the TCU GUI screen. Clicking this soft key opens a sub window which allows the user to view or remove certain categories of events, which are listed in the sub window.

To the right of the Filter soft key is a series of six letters (AC/FWIE). These letters duplicate the entries listed in the Filter sub window mentioned above. Clicking on a letter lightens or darkens that letter. If the letter is lighter, that cat a gory of events are listed in the event log. If the letter is darkened, that cat a gory of events are removed.

Event categories are listed in Figure 3-10.

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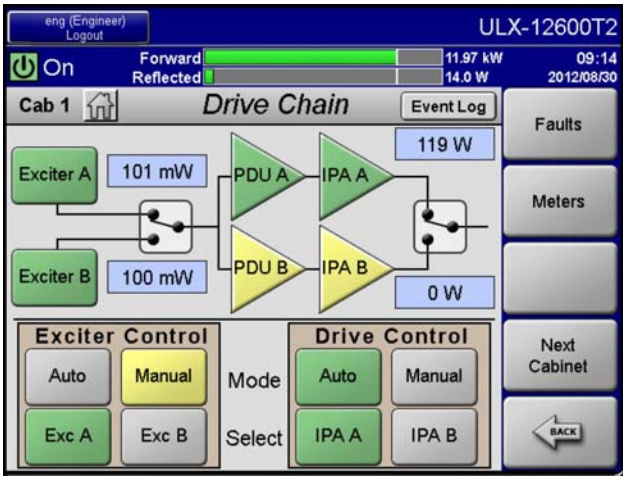
3.5 Drive Chain Main Menu

If you press the Drive Chain button on the HOME screen, it will take you to the screen shown in Figure 3-11. The drive chain menu structure is shown in Figure 3-7 on page 3-9.



To Figure 3-12

To Figure 3-13

To Figure 3-9

Figure 3-11 Drive Chain Screen

Table 3-5 TCU Drive Train Screen

Status Indicator	States	Summary Status
Exciter A and Exciter B	Green/Yellow/Red	This is a summary of the following: 1. Active Exciter Status (Active, Standby, Fault) 2. Exciter A and Exciter B Power Out
IPA A and IPA B	Green/Yellow/Red	This is a summary status of the following: 1. Active PDU & IPA A and PDU & IPA B Status (Active, Standby, Fault). 2. IPA A and IPA B Power Out
Exciter A/B Control	Green/Yellow/Gray	This is a summary status of the following: 1. Active Auto or Manual Control (Yellow, Gray) 2. Active Exciter A or Exciter B Control (Green, Gray
IPA A/B Control	Green/Gray	This is a summary status of the following: 1. Active Auto or Manual Control (Green, Gray) 2. Active PDU/IPA A or PDU/IPA B Control (Green, Gray

The Drive Chain screen is an exciter, pre-driver and IPA control and monitoring screen. It has a power reading for each exciter and IPA output and allows the operator to select exciters and pre-driver/IPAs. It also allows selection of AUTO or MANUAL switching mode for the drive chain when the optional dual exciter system is installed. Specifically it includes:

a. The operational and on-air status of 1 or 2 exciters (the second exciter is optional) pre-drivers and IPA's.
b. The status of Exciters and Drivers A and B. The screen also allows exciter and driver selection.
c. A dual Exciter Control box (located at the bottom of the screen on the left). This section will be grayed out for single exciter systems. For dual exciter systems this box has two exciter buttons and Auto/Manual buttons:
    1. Auto/Manual - Auto should be the standard position for normal operation. Placing it in Manual mode prevents an autoswitch to the alternate drive chain. In AUTO mode, if the on-air exciter drops below 50% of nominal power, or if the on-line exciter experiences a fault, the controller will automatically switch to the secondary exciter (if available). Manual mode could be used if an exciter or driver has been removed for service or for any application where an automatic switch to the alternate drive chain is not desired.

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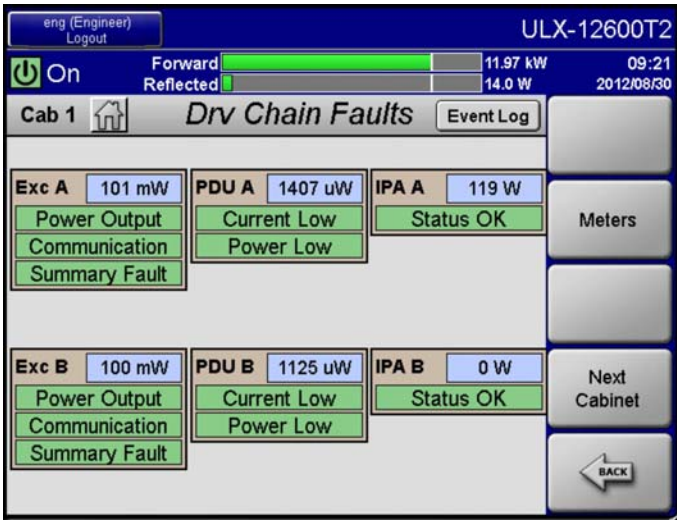
2. Exciter A/B - These buttons select operational exciter. To use these buttons, place the Auto/Manual button to Manual, then press the A or B button to select the on-air exciter.

d. Pre-Driver/IPA Control box (located at the bottom of the screen on the right). This dual driver has 2 switches:

1. Auto/Manual - This toggle button should always be in the Auto position for normal operation. Placing it in Manual mode prevents an autoswitch to the alternate IPA (Preamp/Driver). In AUTO mode, if the on-air predriver/IPAdrops below 50% of nominal power, the controller will automatically switch to the backup pre-driver/IPA. Manual mode could be used if a exciter or driver has been removed for service or for any application where an automatic switch to the alternate IPA(Preamp/Driver) chain is not desired.
2. Pre-driver/IPA A/B - These are the manual selection buttons. To use these buttons, place the Auto/Manual button to Manual, then press A or B to activate the on-air predriver/IPA combination.

3.5.1 Drive Chain Faults

When the "Faults" button in Figure 3-11 is pressed, it will bring up the screen shown in Figure 3-12. This screen is a fault display for exciter and pre-driver/IPA A. Press the Next Drive button to display information for exciter and driver/IPA B. For more information on these faults and what to do if one should occur, refer to the M2X exciter manual or Section 6 of this manual.



To Figure 3-13

To Figure 3-11

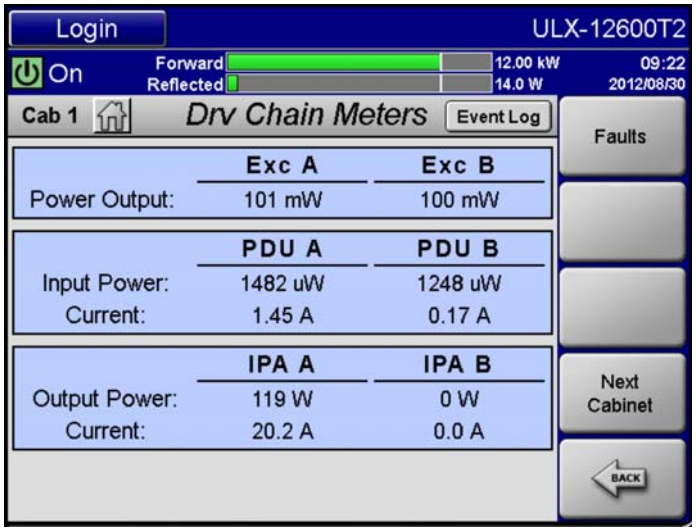
Figure 3-12 Drive Chain Faults Screen

Note

Exciter A is always factory installed as the upper exciter unit. The optional exciter B is installed immediately above the TCU and below the top exciter unit (see layout photo Figure 1-1 on page 1-2).

3.5.2 Drive Chain Meters

When the "Meters" button in Figure 3-12 is pressed, it will bring up the screen shown in Figure 3-13. This screen displays input and output information for exciters and pre-driver/IPA units. Current values for the pre-driver and IPA's are also given.



To Figure 3-12

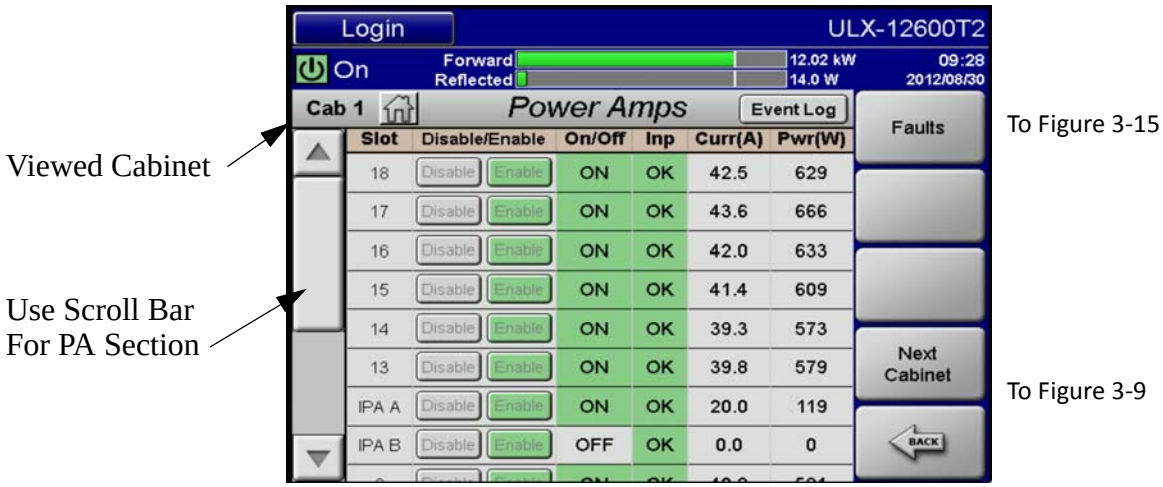
To Figure 3-11

Figure 3-13 Drive Chain Meters Screen

3.6 Power Amps Main Menu

If you press the Power Amps button on the HOME screen, it will take you to the screen shown in Figure 3-14. The Power Amps Menu structure is shown in Figure 3-7 on page 3-9.

For multi cabinet transmitters, pressing the Next Cabinet button toggles the display between the various PA cabinets.



To Figure 3-15

To Figure 3-9

Figure 3-14 Power Amps Screen
(PA Cabinet 1, 12 PA Modules)

This screen shows the current and forward power for individual PA modules in the indicated cabinet. Additional modules in the same cabinet are viewed by selecting the PA's 1-8 or 11-18 buttons in the lower left portion of the bottom of the screen. The PA, Input and On/Off indications on the screen are also status indicators with three possible states:

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a. OK - Green background
b. Fault - Red background
c. OFF - The background is gray.

The On/Off field can be used to toggle individual amplifier modules on or off as needed.

Note

Always be sure that you are accessing the desired cabinet number. The cabinet being viewed is indicated in the upper left corner of the screen.

To get detailed information on a particular PA Module, press the Faults button on the right section of the screen. The Faults button will take you to the PA Faults screen shown in Figure 3-15.

3.6.1 PA Faults

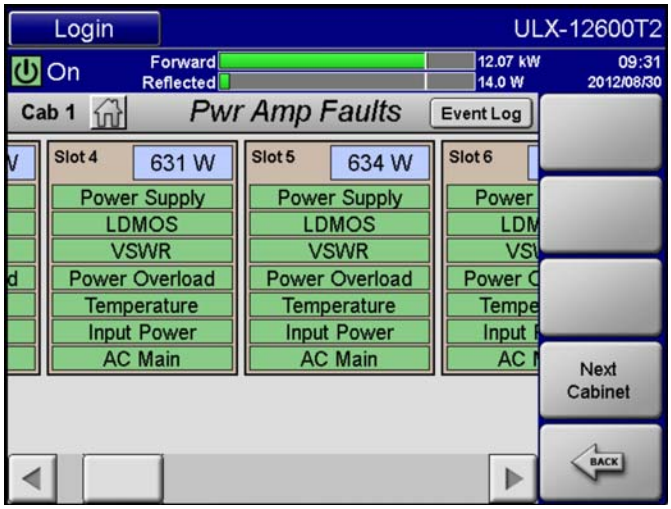
This screen is basically a list of all faults monitored in each PA Module.

- An active fault will be highlighted in red
- A warning condition will be highlighted in yellow.

Note

For a detailed explanation of all PA Faults in Figure 3-15 refer to Section 6, Diagnostics.

For multi cabinet transmitters, pressing the Next Cabinet button toggles the display between the various PA cabinets.



To Figure 3-14

Figure 3-15 PA Faults Screen

PA Modules will fault off at approximately 90 W reflected power. Also, it will display a temperature fault at 65° C ambient temperature (measured by a thermistor on the monitor board) or 90° C pallet temperature.

3.7 Output Main Screen

If you press the Output button on the HOME screen, it will take you to the screen shown in Figure 3-16. The Output Menu structure is shown in Figure 3-7 on page 3-9.

For multi cabinet transmitters, pressing the Next Cabinet button toggles the display between the various PA cabinets.

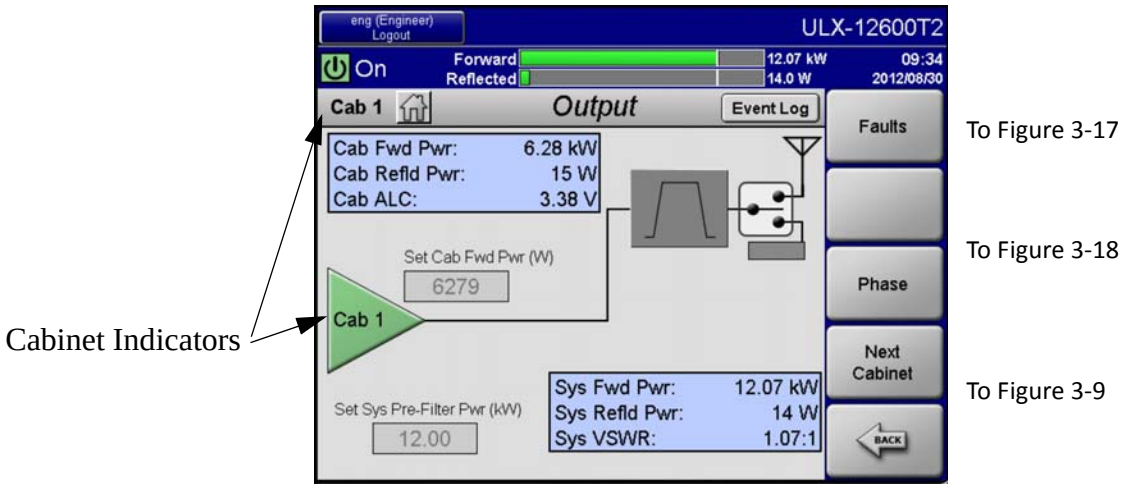


Figure 3-16 Output Screen

The main Output screen is has 3 main areas:

- Power Amplifier Cabinet - Amplifier cabinet icons (triangle) give a status indication of OK (green) or Fault (red).
- RF Output Cabinet & System - These panels give the forward, reflected and aural (analog only) power levels, measured before and after the filter. The cabinet output panel also gives the ALC voltage level.

3.7.1 Output Faults

This screen shows faults which are considered Cabinet or System level such as VSWR, Power High, foldback etc....

- An active fault will be highlighted in red
- A warning condition will be highlighted in yellow

A detailed explanation of each of these faults is given in Section 6, Diagnostics.

For multi cabinet transmitters, pressing the Next Screen button toggles the display between the various PA cabinets.

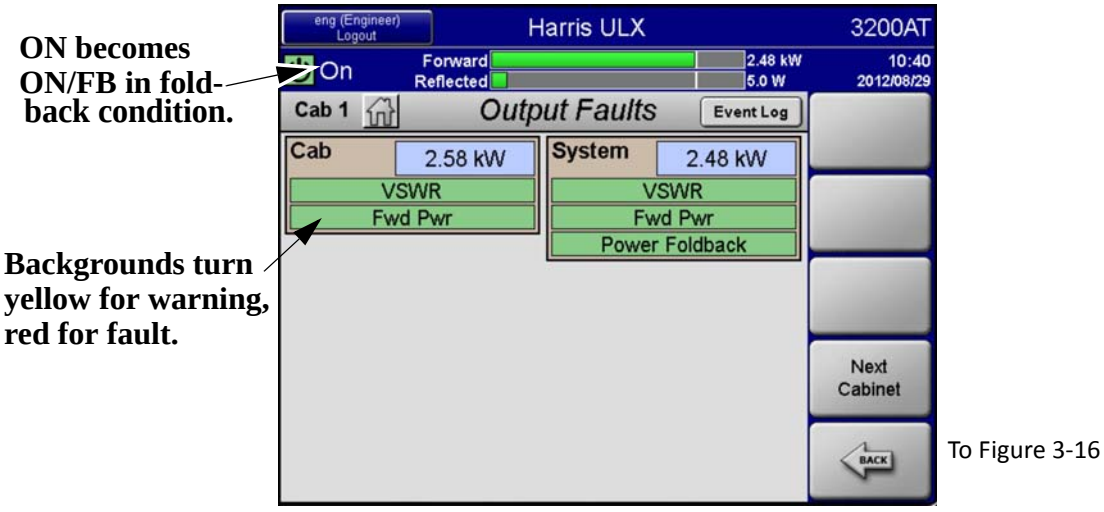


Figure 3-17 Output Faults Screen

VSWR, forward and aural power, and foldback status indicators have backgrounds that are red for fault or yellow for warning. A VSWR fault is indicated when the system VSWR is > 1.9:1, foldback warning is indicated when system reflected power exceeds the Sys. Fldbck Pwr setting. Maximum foldback power threshold level is 2.8% of nominal power setting.

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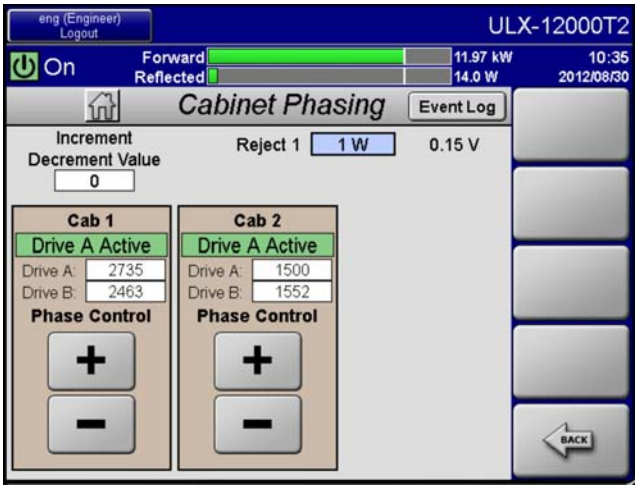
3.7.2 Output Phasing

Multiple PA cabinet systems require proper phasing of the cabinet outputs in order to combine efficiently. This phasing is accomplished by minimizing the power going to the combiner reject loads. Proper output phasing is accomplished by adjusting the cabinet output phases. The predriver phase and gain boards control the cabinet phasing. Adjustments are made using the screen below.

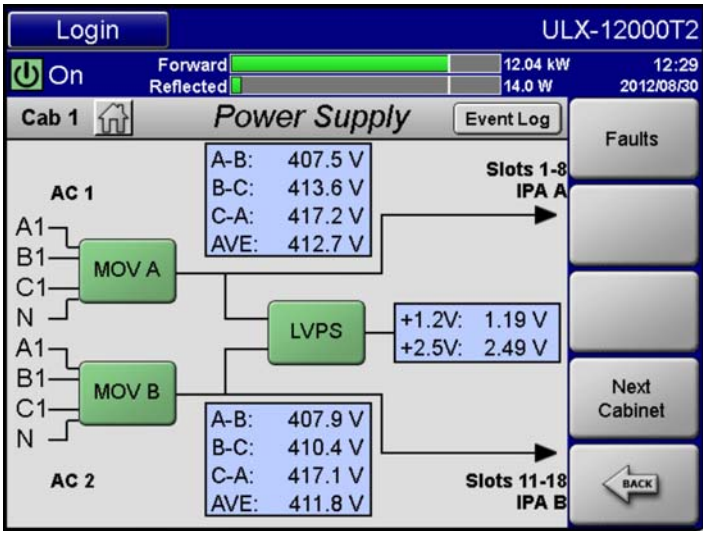


To Figure 3-16

Figure 3-18 Cabinet Phasing Screen

3.8 Power Supply Main Menu

Press the Power Supply button on the TCU Home screen to display the Power Supply screen shown in Figure 3-19.



To Figure 3-20

To Figure 3-9

Figure 3-19 Power Supply Screen:

Table 3-6 TCU Home >Power Supply

Field	Explanation
MOV A	Press softkey to go to PS Faults screen. Softkey changes color to indicate fault (red), warning (yellow), OK (green).
3 Phase Voltages	Box with blue background indicates phase to phase voltages and average of the three phases.
TCU LVPS Voltages	Press softkey to go to PS Faults screen. Softkey changes color to indicate fault (red), warning (yellow), OK (green). Box with blue background indicates voltages developed by TCU low voltage power supplies.

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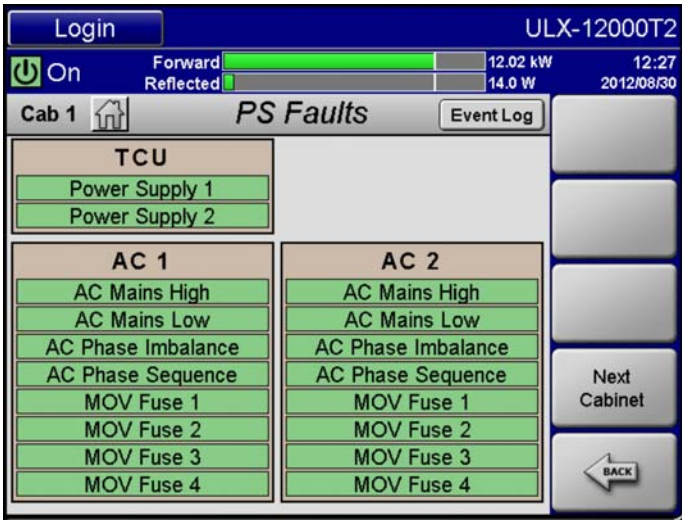
3.8.1 PS Faults

The PS (power supply) Faults screen provides power supply status for the AC mains and low voltage power supplies. An active fault will be highlighted in red, while a warning condition will be highlighted in yellow. For a detailed explanation of these faults, refer to Section 6, Diagnostics.

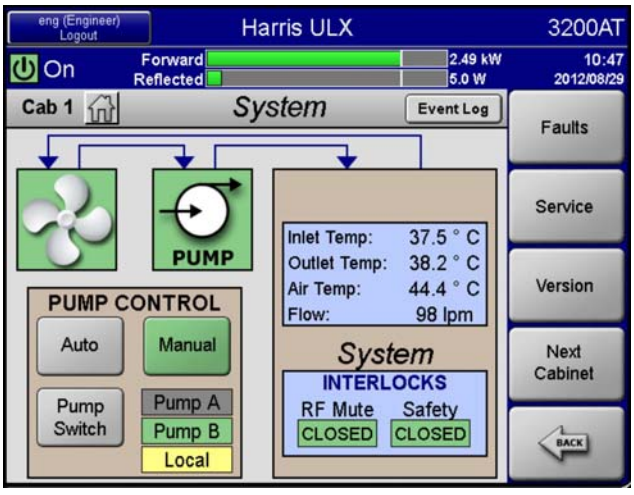


To Figure 3-19

Figure 3-20 PS Faults Screen

3.9 System Screens

If you press the System button on the TCU Home screen, it will take you to the System screen (see Figure 3-21). The System menu structure is shown in Figure 3-7 on page 3-9.



To Figure 3-22
To Figure 3-24
To Figure 3-23
ToFigure 3-9

Figure 3-21 System Main Menu

This screen contains the System Main Menu which gives overall status information and access to additional System screens described in Table 3-7 on page 3-20.

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:

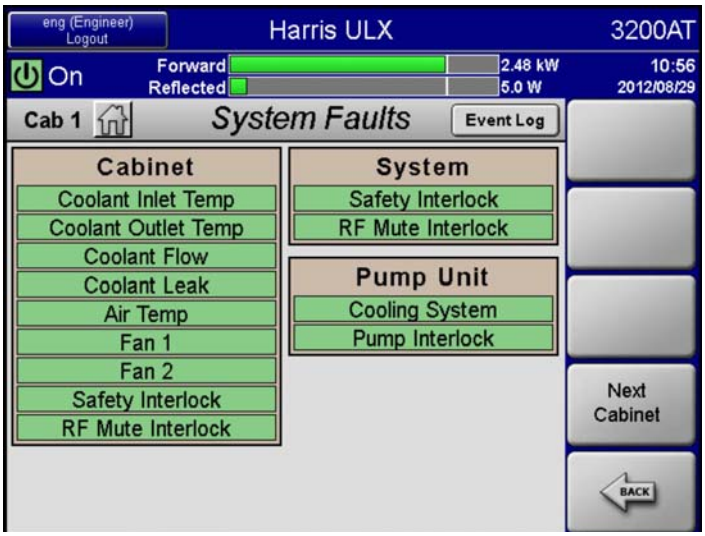
Table 3-7 TCU Home >System

Field	Explanation
CAB1	Provides coolant temperatures, air temperatures and coolant flow (liters per minute). The CAB1 block also provides the status of the RF Mute and Safety Interlocks. Interlocks can read Open (red background) or Closed (gray background)
Pump Status	Pump icon has a green background color if no faults are present or a red background color if faults are active. For more information on faults press "Faults"
Pump Control	Pump A & Pump B for dual pump systems are indicated. This panel would be grayed out (inactive) for single pump systems. The active pump will have a green background. Pumps can be switched from this screen, by pressing A or B only if the pump control panel switch is in the REMOTE mode. Placing the pump control panel in LOCAL mode will disable pump selection on the System GUI screen. For additional information on LOCAL operation and the pump control panel see Section 1.2.9.1, on page 1-12. AUTO or MANUAL can also be selected here. Selecting AUTO allows automatic switchover in case of pump failure in dual pump systems. AUTO is the normal operating mode if the system has dual pumps.

3.9.1 System Faults

This screen is accessed by pressing the Faults button on the System screen. An active fault condition is highlighted in red while a warning condition is highlighted in yellow.

For more information on these faults refer to Section 6, Diagnostics.



To Figure 3-21

Figure 3-22 System Faults Screen

3.9.2 System Software And Hardware Version Screen

The left side of Figure 3-23 shows the software revisions for the TCU controllers.
The right side of Figure 3-23 shows the hardware version for the TCU controllers.
This information should be available before calling for technical support.
Table 3-8 provides space to write in the version numbers for your transmitter.

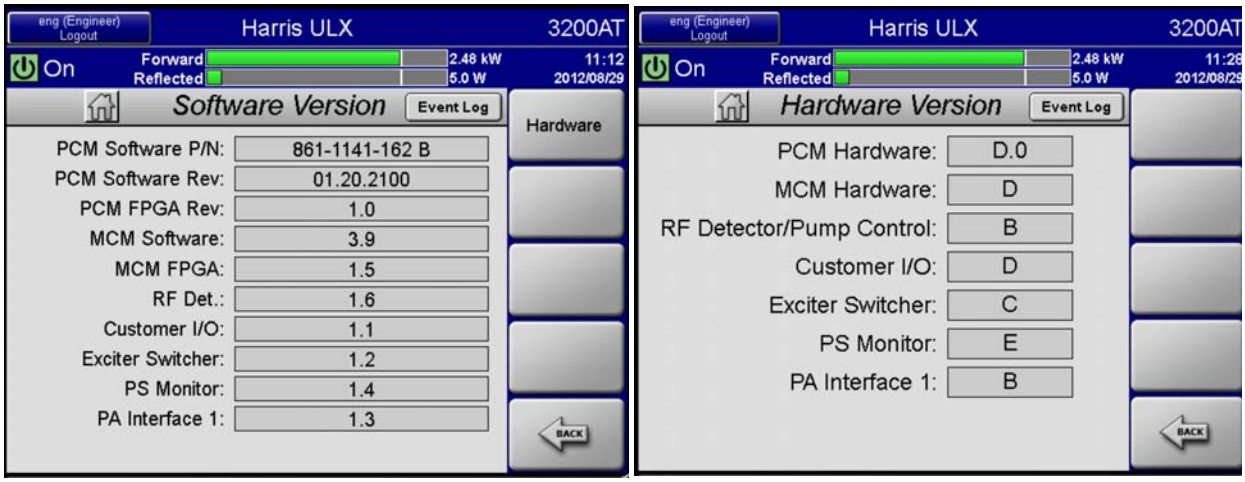


Figure 3-23 Home>System> Software Version>Hardware Version Screens

Table 3-8 ULX TCU Home>Service>Software & >Hardware versions

Software	SW Version	Hardware	HW Version
PCM Software P/N		PCM Hardware	
PCM Software Rev		MCM Hardware	
PCM FPGA Rev		XMTR Interface	
MCM Software		Customer I/O	
MCM FPGA			
RF Det			
Customer I/O			
Exciter Switcher			
PS Monitor			
PA Interface 1		For eight or fewer PA modules.	
PA Interface 2		For more than eight PA modules.	

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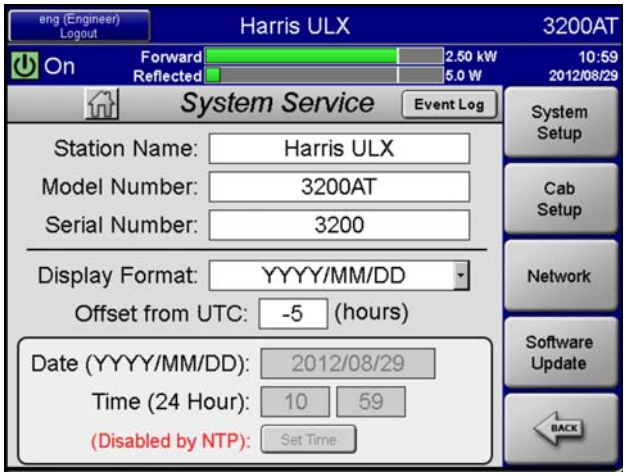
3.9.3 System Service

The System Service screen allows setting of several parameters that involve date and time. See Figure 3-24 and Table 3-9 for details.



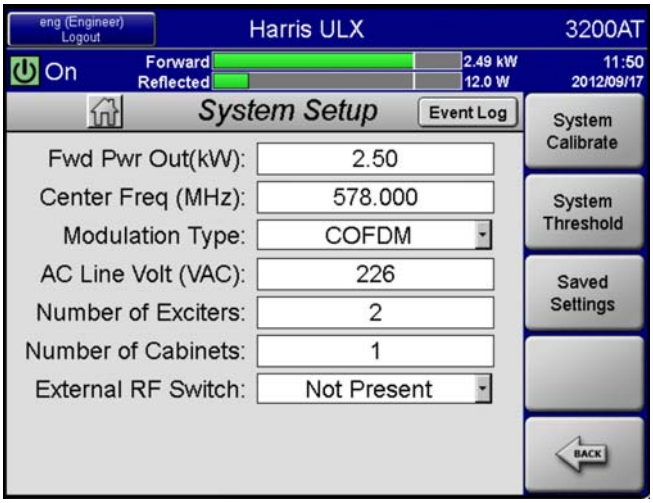
To Figure 3-25
To Figure 3-29
To Figure 3-32
To Figure 3-36
To Figure 3-21

Figure 3-24 System Service Screen (Remote/Local)

Table 3-9 TCU Home >System>Service

Field	Explanation
Station Name	Enter station call or site name. This can be up to 24 characters and will appear at the top of each GUI screen.
Model Number	This value is entered at the factory. The model number must match the transmitter name plate. It is used to gray out portions of the GUI screens which are not used by some models.
Serial Number	This is entered at the factory. Refer to this number if calling for support. Provides this transmitter's serial number (for quick reference). Also available on serial number plate.
Date	Current date and time (clock and calendar set). Note: Date format is MM/ DD.
Time	Time format is based on a 24 hour clock in the format HH:MM:SS
Time Zone	Set time zone for transmitter's location via the drop-down menu. Can directly enter time and date if NTP configuration is set to off. If NTP is on and transmitter is on a network time and date can be set by NTP server.

3.9.3.1 System Setup



To Figure 3-26
To Figure 3-27
To Figure 3-28
To Figure 3-24

Figure 3-25 System Setup Screen

Table 3-10 TCU Home>System>Service>System Setup

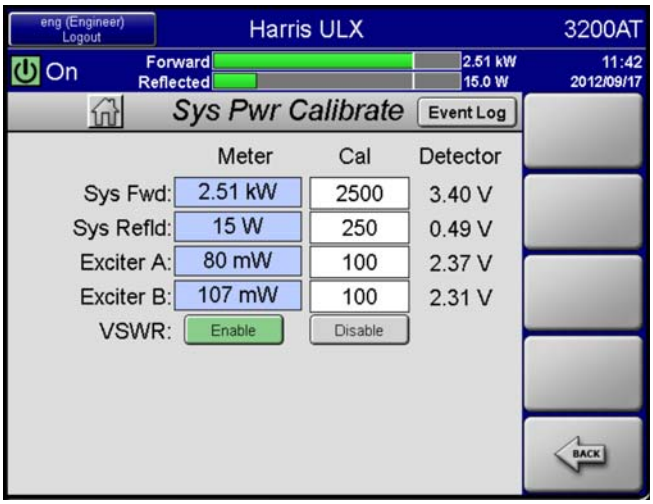
Field	Explanation
System (Forward) Pwr Out (W)	Set this value to the system nominal power output. This value determines the 100% level on the GUI power out bar.
Center Freq (MHz)	Enter the center frequency (digital systems) or visual frequency (analog systems) for the desired operational channel. This sets the transmitter and exciter frequencies. In a dual exciter system, it will set both exciters.
Modulation Type	Select the system modulation type from the values displayed in the pull down menu.
AC Line Volt (VAC)	Set this to the nominal AC line voltage at the transmitter site.
Number of Exciters	Set this to either 1 or 2 depending on how many exciters are in the transmitter.
Number of Cabinets	Set this to the number of PA cabinets in the system.
External RF Switch	Enables switch that changes transmitter RF output between antenna and test load.

Caution

TRANSMITTER FREQUENCY SHOULD ONLY BE CHANGED IF THE FILTER AND RF SYSTEM COMPONENTS ARE TUNED FOR THE NEW FREQUENCY.

3.9.3.1.1 System Power Calibrate

See Sections "5.9 Analog Power Calibrations" on page 5-12 and "5.10 Digital Power Calibrations" on page 5-21 for procedures that utilizes these screens.



To Figure 3-25

Figure 3-26 System Power Calibrate Screen

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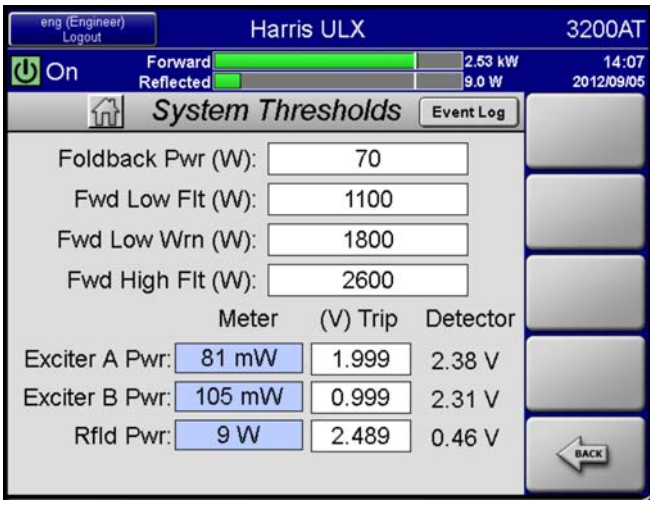
3.9.3.1.2 System Thresholds

The System Thresholds screen is used to set the various RF levels which will generate a warning or fault.



To Figure 3-25

Figure 3-27 System Thresholds Screen

Table 3-11 TCU Home>System>Service>Setup>Thresholds

Field	Explanation
Foldback Power	This is the system reflected power level which causes power foldback to start. The maximum value that can be entered here is 2.78% of nominal power. Note: When set to 2.78% foldback starts when the system VSWR reaches a level of 1.4:1.
Fwd Low Power Flt	This is the system low forward power level which causes a fault.
Fwd Low Pwr Warn	This is the system low forward power level which causes a warning.
Fwd High Pwr Flt	This is the system high forward power level which causes a fault.
Exc Pow Meters	This shows the output power of the exciters.
Ref Power Meter	This shows the system reflected power. This reading results from the system reflected detector voltage value indicated in column 3.
Exc A Low Pwr Trip	This is the Exciter A low RF output detector voltage level which causes a trip.
Exc B Low Pwr Trip	This is the Exciter B low RF output detector voltage level which causes a trip.
Ref Pwr Trip	This is the reflected output detector voltage level which causes a System VSWR fault. When the detector voltage reaches the trip voltage a System VSWR fault occurs. The system VSWR fault trip point occurs at a VSWR of 1.9:1, which equals a reflected power level of 9.6% of the system nominal forward power setting.
Detector Voltage	Column displays the exciter and the reflected power detector output voltages.

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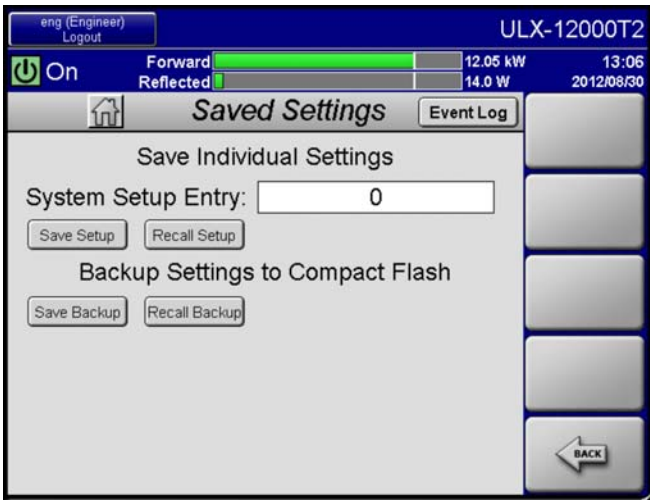
3.9.3.1.3 Saved Settings

The System Setup Entry button allows storage of up to eight setups (0 through 7) for the purpose of N+1 operation. All the settings and calibrations for the transmitter are saved in the MCM module. This means the transmitter can change to any one of eight channels and be fully calibrated by simply recalling the set up entry. The N+1 controller will send to the TCU the set up the entry that needs to be recalled, the setup parameters include frequency of operation.



To Figure 3-25

Figure 3-28 System Saved Settings

System Setup Entry, Enter a number from 0 to 7 in this field. The number that is entered in this field will be the storage location for all changes made to individual setup settings. The changes are stored automatically as the changes are made. Typically the factory uses setup entry 0.

For example, if you want to set up the transmitter for CH29 and store it in entry 3, you enter 3 in the System Setup Entry and then complete the CH29 setup by changing frequency, power out, and calibration. The changes are automatically saved as setting 3 as the changes are made.

Care must be taken not to overwrite previous setups in cases where a transmitter is setup to operate on two different frequencies. Only press Save Setup when a complete save of all parameters is required.

Caution

TRANSMITTER FREQUENCY SHOULD ONLY BE CHANGED IF THE FILTER AND RF SYSTEM COMPONENTS ARE TUNED FOR THE NEW FREQUENCY.

Save Setup and Recall Setup Buttons

When a system setup is completed the Save Setup button is pressed to save that setup to the MCM board EEPROM. Pressing the Recall Setup button recalls the numbered system setup entry from the MCM Eproms.

Save Backup and Recall Backup Buttons

When the Save Backup button is pressed, all eight system setup entries (the contents of the MCM EEPROM) are saved to the MCM compact flash card. This card can be removed and transferred to another transmitter, a replacement MCM card, or to a replacement TCU.

The Recall Backup soft button can be used to move setup files on the flash drive to MCM EEPROM.

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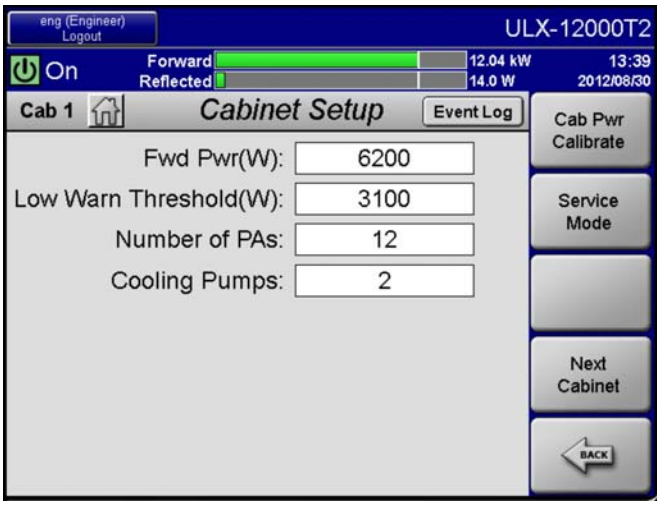
3.9.3.2 Cabinet Setup

The cabinet power levels, low power warning, number of PAs, and the number of liquid cooling pumps is set in the cabinet setup screen.



To Figure 3-30

To Figure 3-31

To Figure 3-24

Figure 3-29 Cabinet Setup Screen

Table 3-12 TCU Home>System>Service>System Setup>Cabinet Setup

Field	Explanation
Cab FWD Pwr Out (W)	Set cabinet nominal output power here. This is the power out of the cabinet before the combiner or filter. This needs to be set for each cabinet. Sets cabinet nominal power used to set ALC level. Maximum cabinet power is limited to 10% over this value.
Low Warn Threshold	When the cabinet forward output power reaches this level, a low power warning is produced
Number of PAs	Enter the number of PA modules in the selected cabinet. This needs to be set for each cabinet.
Cooling Pumps	Set this to either 1 or 2 depending on how many pumps are in the pump module for this cabinet. This needs to be set for each cabinet.

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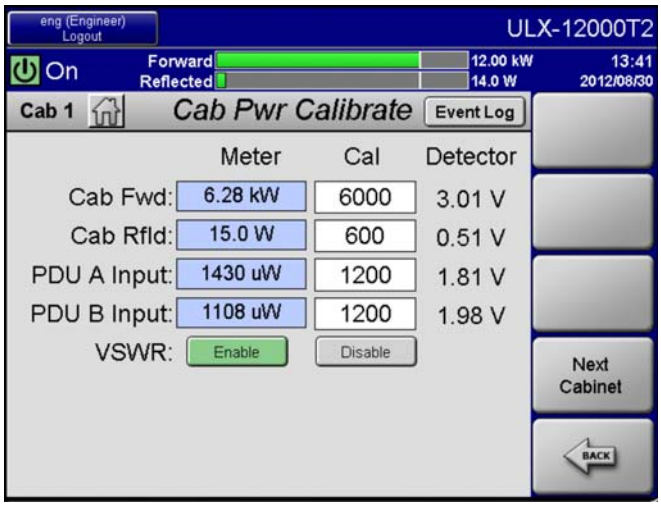
3.9.3.2.1 Cabinet Power Calibrate

See Sections "5.9 Analog Power Calibrations" on page 5-12 and "5.10 Digital Power Calibrations" on page 5-21 for procedures that utilize this screen.



To Figure 3-29

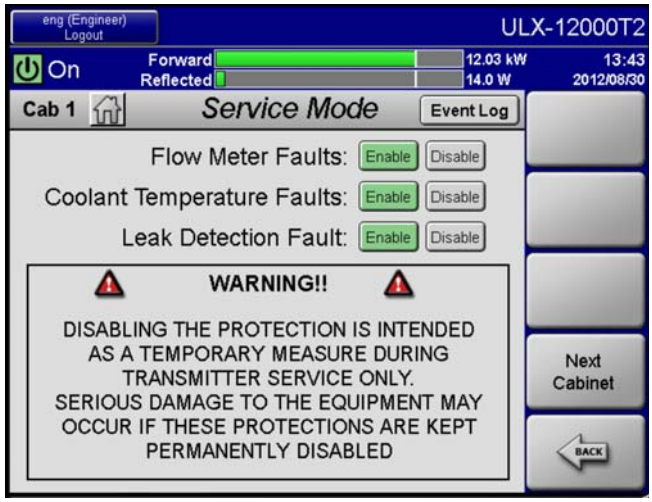
Figure 3-30 Cabinet Power Calibrate Screen

The Cal boxes can be selected to open up a keyboard entry screen. The VSWR Enable and Disable buttons are used during reflected power calibration. The process is described in Section 5.

3.9.3.2.2 Service Mode Screen

Warning

*SERVICE MODE IS TO BE IMPLEMENTED **ONLY** WHILE SERVICING THE COOLING SYSTEM! FAULTS **MUST** BE RESET TO 'ENABLED' AT ALL OTHER TIMES. FAILURE TO DO SO MAY RESULT IN SERIOUS DAMAGE TO THE TRANSMITTER!*



To Figure 3-29

Figure 3-31 Service Mode Screen

Press 'Enable' buttons to disable indicated fault protection. Press again to enable fault protection immediately on completion of servicing. Before disabling any of the three faults normal operation must be confirmed. For example, should the flow meter fault be displayed the operator must confirm that the fault is caused by a bad flow meter component and that adequate flow is present in the cooling system before disabling the fault. The fault should be enabled as soon as the bad flow meter component is replaced.

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3.9.3.3 System Network Screen

This screen provides information about computer network settings. MAC, Mode (Static or DHCP), IP, Netmask, Gateway and DNS Source settings are given. Enter values specific to your environment.

To Figure 3-33

To Figure 3-35

To Figure 3-24

Figure 3-32 System Network Screen

Table 3-13 TCU Home>System>System Service>Network

Field	Explanation
Hostname	Label that identifies transmitter on network router. Used for network administration.
MAC	Ethernet port MAC (Media Access Control) address is displayed.
DHCP	Drop menu and select Enabled or Disabled. If Disabled is selected, click & fill fields (obtained from local IT system administrator)
IP Address	Displays IP address in DHCP mode. Allows entry in Disabled mode.
Netmask	Displays Netmask in DHCP mode. Allows entry in Disabled mode.
Gateway	Displays Gateway address in DHCP mode. Allows entry in Disabled mode.
DNS Source	Domain name system source. Choices are Manual or DHCP. If manual is selected user must enter DNS1 and or DNS2. If DHCP is selected DNS1 and DNS2 are automatically set.
DNS 1	Host name for DNS source.
DNS 2	Host name for DNS source.

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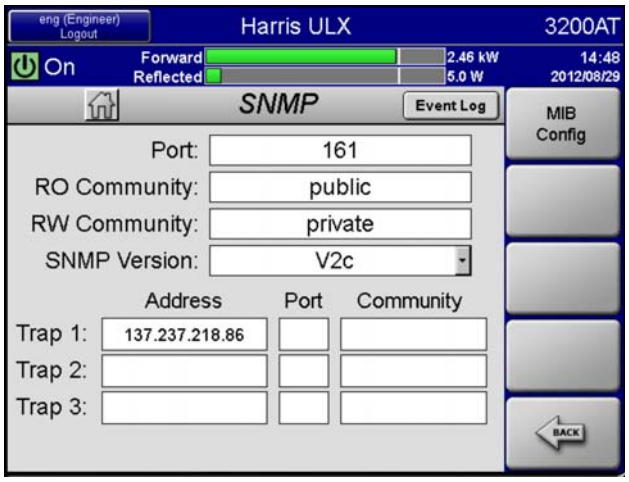
3.9.3.3.1 SNMP Configuration



To Figure 3-34

To Figure 3-32

Figure 3-33 SNMP (Simple Network Management Protocol) Config screen

Table 3-14 TCU Home>System>Service>Network>SNMP Config

Field	Explanation
Port	Enter the port number to be used. Choices are 161 and 8170 through 8179. Port 161 is the default.
Protocol	Choice is 'UDP' or 'TCP'.
RO (read only) Community	This is a user defined password which allows a 'set' to be performed. Default is 'private'.
RW (read write) Community	This is a user defined password which allows a 'set' to be performed. Default is 'private'.
SNMP	Version choices are: V1 or V2C. Version 1: The trap which is sent tells of an occurrence of an event but gives no details. Version 2C: This trap tells of an occurrence of an event and gives details concerning it.
Trap IP	A trap is a list of variables which are sent to the trap IP address specified here. Five Trap IP addresses can be entered.

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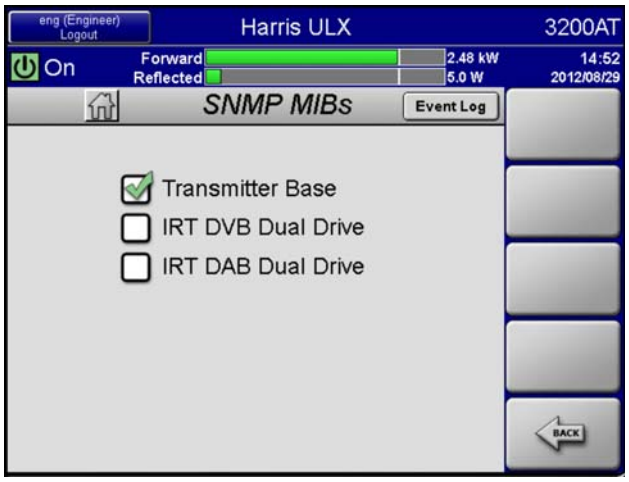
3.9.3.3.2 SNMP MIBs

A MIB is a pre-defined Management Information Database using the SNMP protocol.



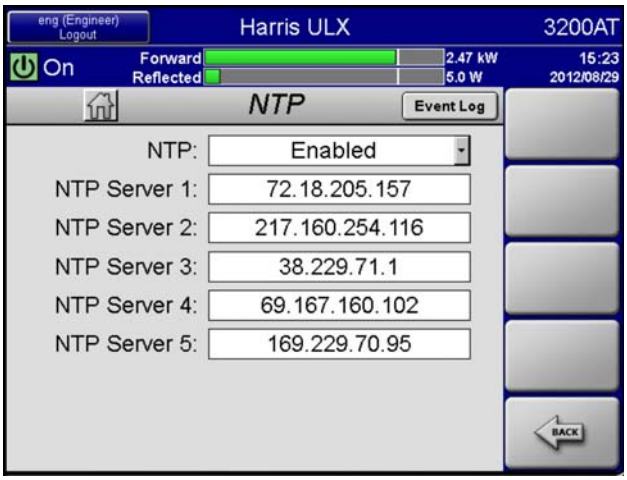
To Figure 3-33

Figure 3-34 SNMP MIBs

Three MIBs can be selected:

- **Transmitter Base** is a database which is common to all Harris transmitters, and would therefore be the usual default choice.
- **IRT** is a German standard database which Harris supports. It covers **DVB** (digital video broadcast) or **DAB** (digital audio broadcast).
  Dual Drive, shown above, indicates that the transmitter system includes dual exciters. It would state Single Drive if the transmitter system had only one exciter.

3.9.3.3.3 NTP Screen



To Figure 3-32

Figure 3-35 NTP Screen

Table 3-15 TCU Home>System>Service>Network>NTP Config

Field	Explanation
NTP	(Network Time Protocol) can be set On or Off.
NTP Server IP	Enter NTP server IP numbers. This assumes the desired NTP server is reachable from the transmitter IP connection.

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3.9.3.4 Software Management

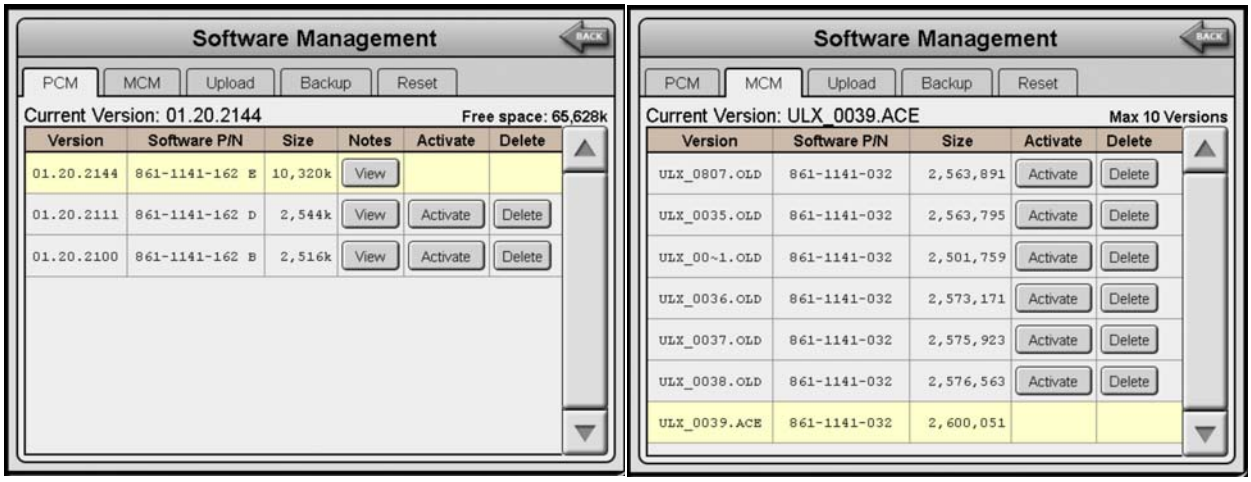

Figure 3-36 Software Management PCM And MCM Screens

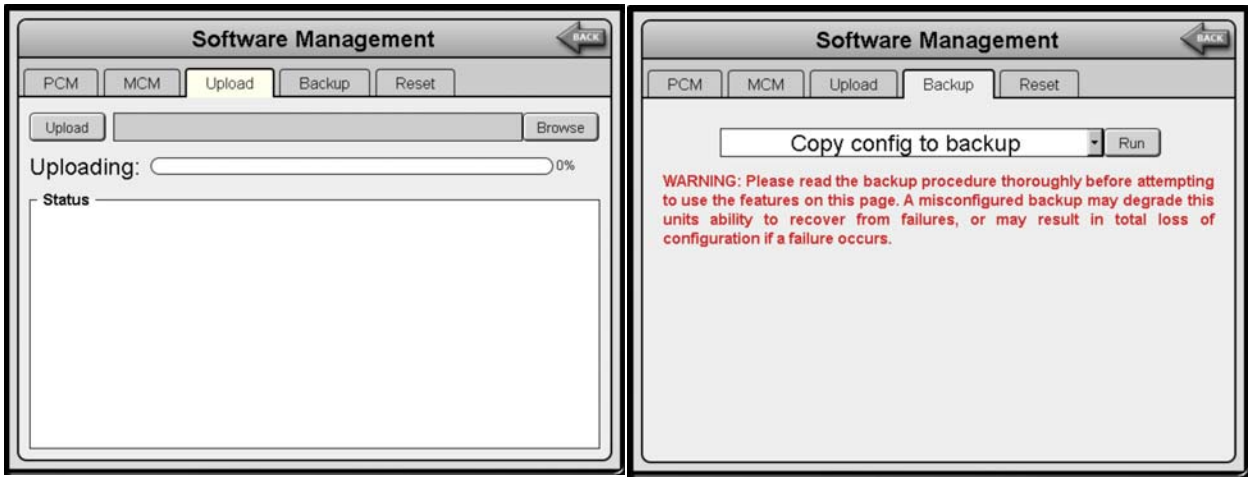

Figure 3-37 Software Management Upload And Backup Screens

Figure 3-38 Software Management Reset Screen

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Table 3-16 TCU Home>System>System Service>Software Management

Field	Explanation
PCM Tab, Figure 3-36 Left Side	
Explanation	The software version which is highlighted yellow is the active PCM card software. The rows in blue represent other PCM software versions. The soft keys allow the release notes of all versions to be reviewed, and other software versions to be activated or deleted.
View	Press tab to review the software version release notes.
Activate	Press tab to load this version of software into TCU PCM.
Delete	Press tab to delete this version of software.
MCM Tab, Figure 3-36 Right Side	
Explanation	The software version which is highlighted yellow is the active MCM card software. The rows in blue represent other MCM software versions. The soft keys allow the other software versions to be activated or deleted.
Activate	Press tab to load this version of software into TCU MCM.
Delete	Press tab to delete this version of software.
Upload Tab, Figure 3-37Left Side	
Explanation	This upload function can be used to update the TCU MCM or PCM2 software. For this process, you must be logged into the TCU as an engineer. Login can be through your network, via the RJ45 connector on the top of the transmitter cabinet, or locally through the top RJ45 connector on the PCM-2 card.
Upload	Used to locate and select TCU software update files. The software file must have been downloaded from the Harris web site to your computer so that it can be uploaded from your computer to the TCU. MCM software part number is 861-1141-032, a typical software file name will be similar to ULX_0040.ace. Where 0040 indicates the version. PCM-2 Software part number is 861-1141-162, a typical software file name will be similar to ULX_861-1141-162_E_01.20.2144.pcm. Where E_01.20.2144 indicates the version.
Browse	Press to upload software file into TCU, see procedure below. Press the Browse soft key on the screen and locate the previously downloaded software file from your computer. Next, press the Upload soft key to transfer the file to the TCU. Once uploaded the software can be activated on the PCM software management screen (for a nnn.pcm software file) or on the MCM software management screen (for a nnn.ace software file).
Backup Tab,Figure 3-37 Right Side	
Pull Down Menu	The backup function saves a copy of the PCM-2 SD card image, configuration, and software files to the NAND flash memory on the single card computer (daughter board on the TCU PCM-2 card). Should the SD card be damaged or removed the PCM software can be loaded from the flash memory module on the PCM daughter board. The Backup routine should be performed after software updates or following configuration changes that need to be saved. Backup pulldown menu choices are: Initialize the backup drive Partition the backup drive Backup the kernel partition Backup the initrd partition Backup the system partition Backup the writable partition Copy config to backup To perform a full backup simply press Run after selecting each of the menu choices (one at a time) in the sequence given above. The run time will vary from step to step. If only a configuration backup is required simply select “Copy config to backup” and then press Run.
Run	Press Run to perform selected backup.
Reset Tab, Figure 3-38	
Restart	Press to perform a software reset. Takes 2-5 seconds. PCM apps are closed and restarted. Will not take transmitter off-air.
Reboot	Press to perform a hardware and software reset. Takes 10 - 20 seconds. PCM card hardware and apps are closed and restarted.

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Section-4 Theory 4

4.1 Introduction

This section contains detailed descriptions of the Maxiva ULX Series transmitter, its internal sub-assemblies and any pertinent information regarding the external assemblies such as the pump module and heat exchanger.

The rest of this section will be broken up into 4 main topics:

- Control System & TCU
- RF System
- Power Supplies
- Cooling System

4.1.1 Active Logic Symbols

Each logic signal has an active and inactive state and a unique name within the system. To differentiate between active high or active low logic states on the schematics, a forward slash (/) is placed in front of an active LOW signal name such as /RF_MUTE. This means that if this logic line is pulled low, the transmitter RF will be muted. By the same logic, the signal RF_MUTE_LED (an active high signal with no forward slash) will turn on the RF mute LED when it goes high.

In some cases, a logic signal may act as a toggle with both states active, as with the signal /ON_OFF, where LOW = ON and a HIGH = OFF. If this signal is inverted it would be ON_/OFF.

4.2 Block Diagram Descriptions

See Section 1, Introduction, in this manual for a basic transmitter overview, model numbers, power outputs and block diagram descriptions. Figure 4-1 gives a simplified transmitter block diagram. There is also a more detailed overall transmitter block diagram at the front of the schematic package that comes with the transmitter.

As a standard practice, the first page of a PC (printed circuit) board schematic is a block diagram of that board.

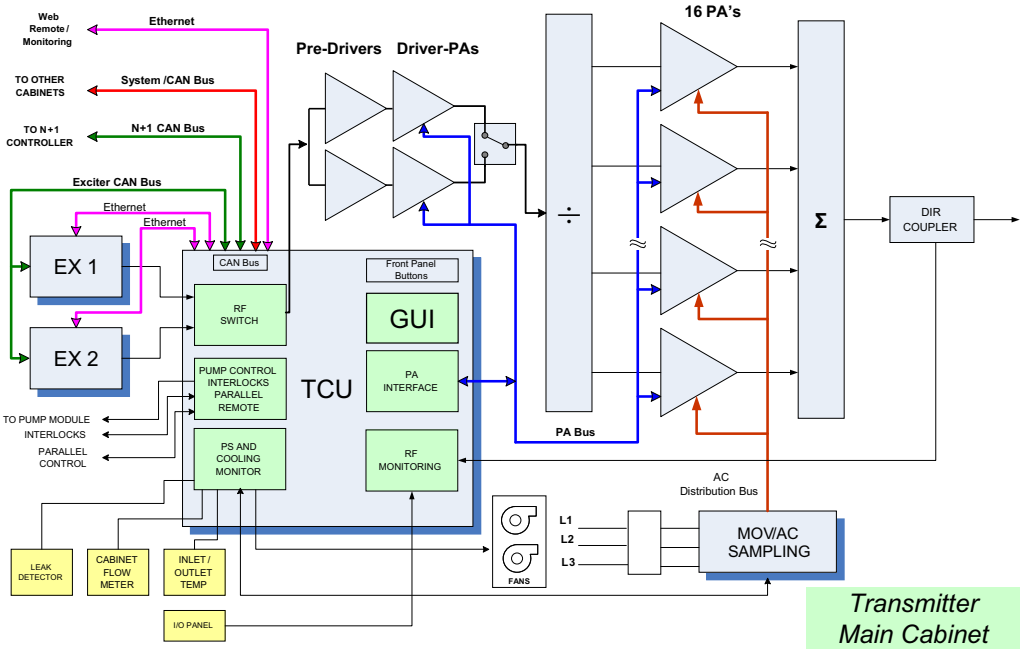

Figure 4-1 Maxiva ULX Cabinet Block Diagram

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4.3 AC Distribution

Three phase AC mains must be supplied to the PA cabinets via circuit breaker CB23 and CB24 on the AC mains input assembly (A15). The transmitter can accept 208-240VAC (Delta or WYE) or 380-415VAC (WYE) by changing jumpers or connections in four areas:

- Terminal boards TB1 and TB2 are in the AC distribution panel. The TB1 and TB2 Jumpers are described in Section 2.8.3, Checking AC Configuration, on page 2-13.
- Parallel MOV boards (A15A1 & A15A2). MOV board jumpers are shown on sheet 8 of the PA Cabinet Main Wiring Diagram, drawing number 843-5601-001.
- Driver and PA backplane boards. On the IPA and PA backplane boards, drawing numbers 801-0222-131 and 801-0222-101 respectively, the jumpers on TB1, TB2, and TB3 are connected between terminals 2 and 3 for 208 to 240 VAC Delta or WYE and connected between terminals 1 and 2 for 380 to 415 VAC WYE connections.
- A neutral connection is required, from the AC service entrance to CB23 and CB24 (if used) for the 380 to 415 volt WYE connection, but no neutral connection is required for the 208 to 240 volt Delta or WYE connections. 440 to 480 VAC Delta or WYE connections require a step down transformer.

If properly jumpered there will be three phase 208-240V AC applied to each driver and PA module.

4.4 Transmitter Control System

The Maxiva ULX Series transmitters utilize a very advanced but simple to use control system. The fully outfitted, single cabinet, liquid-cooled transmitter consists of 1 power amplifier control cabinet, 2 preamplifiers, 2 IPAs (drivers), 16 PA (power amplifier) modules, a TCU (transmitter control unit), one or two M2X exciters and a cooling system that includes interconnecting plumbing, pump module, and heat exchanger (cooler) unit.

In order to reduce cost and simplify the design, the amplifiers and IPA (driver) modules do not contain micro controllers. A CPLD (complex programmable logic device) based monitor board in each PA and IPA is responsible for reporting faults back to the TCU and taking action when the ON/STBY command is issued from the TCU.

In multi-cabinet systems, there is a TCU in each cabinet and the main cabinet (no. 1) TCU contains a GUI (graphical user interface) screen and assumes the role of the master controller for the system. The TCUs in the other PA cabinets are considered slaves; they don't have GUI screens and do not require all of the cards used in the main cabinet TCU. For additional information on the TCU and the various boards that it contains see 1.2.3 on page 1-5.

The TCUs in each cabinet contain an MCM (master control module) module. The MCM modules in each TCU are connected by the *system bus*. The *system bus* originates in the main cabinet TCU and connects to the MCM cards in all other TCUs.

The TCU in each cabinet uses the *cabinet bus, Drive A and B busses, and BP 1 through BP 4 busses* for control and communications within each cabinet. These buses tie the MCM and two PA Interface boards (in the TCU) to all of the RF amplifiers in the cabinet. The use of separate system and cabinet bus allows each cabinet to operate independently in case a cabinet fails.

4.4.1 Graphical User Interface (GUI)

The GUI is a touchscreen, panel PC which includes 5.25" color, 1/4 VGA display. This is the primary local interface for the operator but is not required to operate the transmitter. The primary operator controls, ON, OFF, RAISE, LOWER are located on the front panel next to the GUI. Operation and navigation of the GUI is covered in Section 3 of this manual. The GUI screen is present only in the main TCU (cabinet 1 in multi cabinet systems).

4.4.2 Transmitter RF Power Control

The IPA and PA modules have no gain adjustment. The transmitter RF output power is controlled via the phase and gain board located in the predriver modules. The predrivers are the only components in the drive chain (besides the exciter) capable of adjusting their RF power based on a command from the MCM.

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The TCU in the main cabinet contains a PCM (processor control module) which acts as the transmitter interface. However, a depopulated TCU is present in each added PA cabinet. The MCM card monitors the power sample from its cabinet and issues the proper voltage to the predrivers to maintain the cabinet power regulation. This ALC loop resides in each cabinet. *There is no System ALC Loop.*

In addition to providing main cabinet power regulation, the main TCU also issues the cabinet power reference. This reference is used by the ALC loop in each cabinet to raise or lower the transmitter power as commanded by the end user. This signal is sent via CAN messages. Figure 4-2 on page 4-3 illustrates the power control functionality. If the main TCU is down, the additional PA cabinets maintain their current power output.

In each cabinet, the cabinet power reference is compared to the detected cabinet RF power sample and the resultant error voltage (cabinet # ALC) is produced. The error voltage is used to control the predriver gain, which determines the cabinet output power.

The local TCU power raise and lower buttons provides a means of individual cabinet power control with the ALC enabled. This provides a means of setting and calibrating the individual cabinet output power to ensure correct cabinet combining in a multiple cabinet system.

The TCU in each cabinet has power control AUTO and manual buttons. These buttons turn cabinet ALC on and off. If the ALC is disabled, the cabinet power can be raised or lowered via the local TCU power raise and lower buttons. This is an open loop mode and is intended primarily as a cabinet test mode (cabinet operated independently of the main TCU).

The TCU samples the cabinet forward power ten times per second. It's main role is to maintain cabinet power regulation to compensate for thermal drift in the amplifiers.

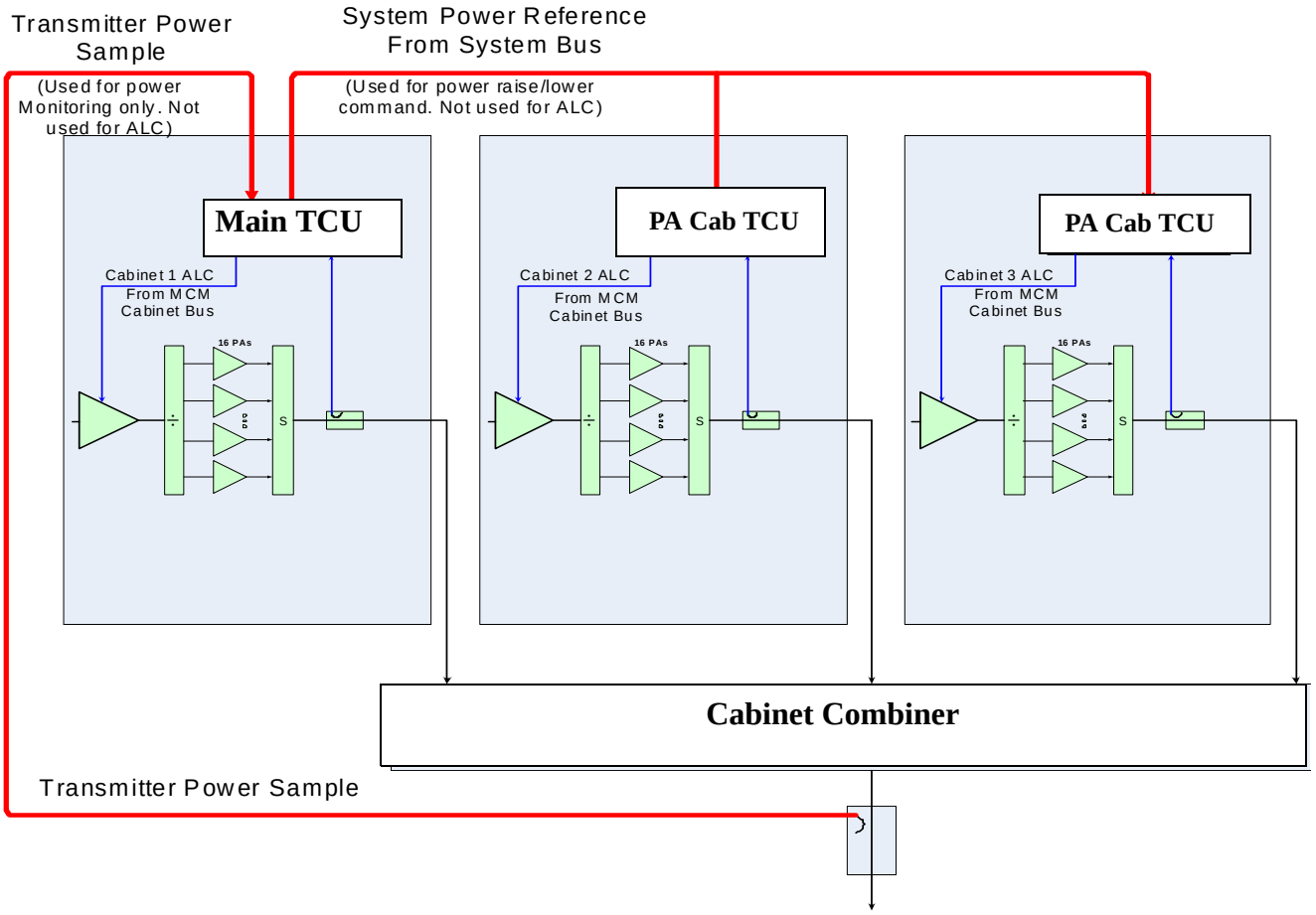
Transmitter Power Sample
(Used for power Monitoring only. Not used for ALC)
System Power Reference From System Bus
(Used for power raise/lower command. Not used for ALC)
Main TCU
PA Cab TCU
PA Cab TCU
Cabinet 1 ALC From MCM Cabinet Bus
Cabinet 2 ALC From MCM Cabinet Bus
Cabinet 3 ALC From MCM Cabinet Bus
16 PAs
16 PAs
16 PAs
Cabinet Combiner
Transmitter Power Sample

Figure 4-2 Control System Simplified Block Diagram

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4.4.3 TV Sync Distribution

The TV sync signal is routed from the exciters to J5 and J6 on the down converter board, which is located inside the main and PA cabinets on the ceiling. In the down converter board, the sync from the on air exciter is routed to sync output connectors J7, J8, and J9. From J7, the sync is routed to the IPA and PA backplanes to provide peak of sync detection for the IPA and PA modules. The sync outputs from J8 and J9 are routed from the main cabinet to the additional PA cabinets in a multi cabinet system.

4.4.4 TCU Control

The heart of the Maxiva control system is the TCU (transmitter control unit). Each cabinet contains a TCU. The main cabinet (cabinet 1 in multi cabinet systems) contains an enhanced TCU (with a GUI screen), while additional PA cabinets contain a basic TCU (without GUI screen). The basic TCU will not be equipped with all of the same components as the enhanced unit. The cabinet 1 TCU assumes the role of master controller in multi cabinet systems. TCUs in added PA cabinets are slaves.

4.4.4.1 MCM Card

Each TCU contains an MCM (master controller module) card. The MCM is a microprocessor based controller used for all critical transmitter control functions. The MCM cards in each cabinet TCU (in multi cabinet systems) are tied together via the *system bus*. The system bus allows interchange of control and status information between the main cabinet TCU and additional PA cabinets. The MCM is responsible for maintaining life support operation when the PCM card and GUI are not operational. The system bus connector (J6) connections are provided in Table 4-10 on page 4-16.

The cabinet bus connector (J5) has limited use in this transmitter. Pin 7 is the only signal used in the cabinet bus. It sends the PA_voltage_select signal to the IPA and PA backplanes, from which it is sent to the IPA and PA modules, where it controls the DC output voltage from the eight AC to DC converters in each module.

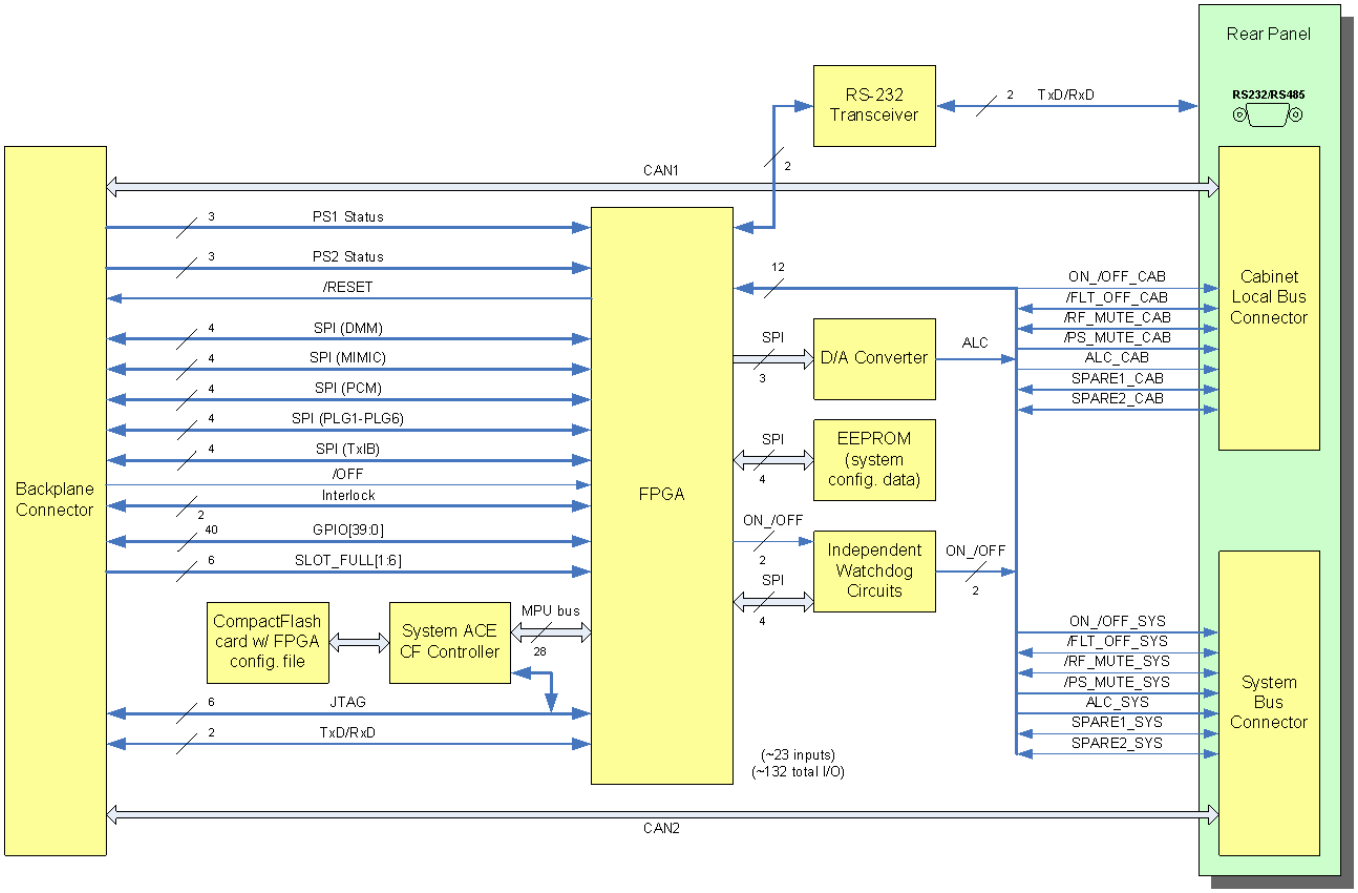

Figure 4-3 MCM Card Block Diagram

4.4.4.2 PCM Card

The TCU in each cabinet also contains a PCM (processor control module) card. The PCM card contains the ARM based micro module running embedded Linux OS. The PCM allows use of an optional 5.25" color 1/4 VGA GUI panel PC touch screen for enhanced monitoring and control. It also provides exciter and multi cabinet data collection, fault logs, web remote connectivity via TCP/IP connection, SNMP error trap reporting and configuration and setup interface.

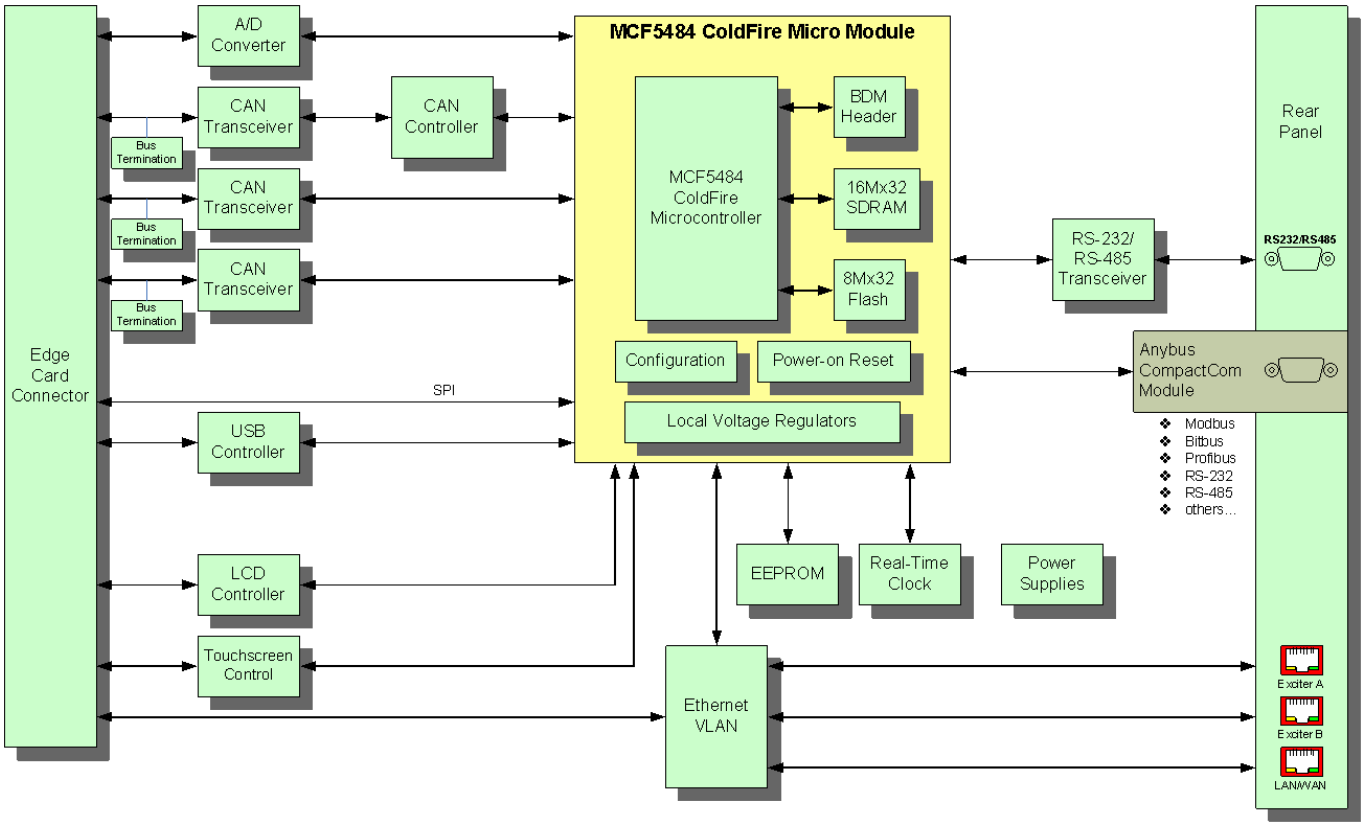

Figure 4-4 PCM Block Diagram

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4.4.4.3 RF Detector/Pump Control/Interlocks Card

The RF detector/pump control/interlocks card is located in the TCU. It is made up of a main and daughter board. The card contains seven RMS detectors with adjustable trips set by EPOTS (electronic potentiometers). Pump control and interlock wiring is combined on one D25 pin connector J3. For analog transmitters the card also serves as an interface to the analog down converter board via another D25 connector J2. Figure 4-5 on page 4-6 shows the RF Detector/Pump Control/Interlocks card connectors on the rear of the TCU and how the board is connected to the Customer I/O board at the top of the transmitter.

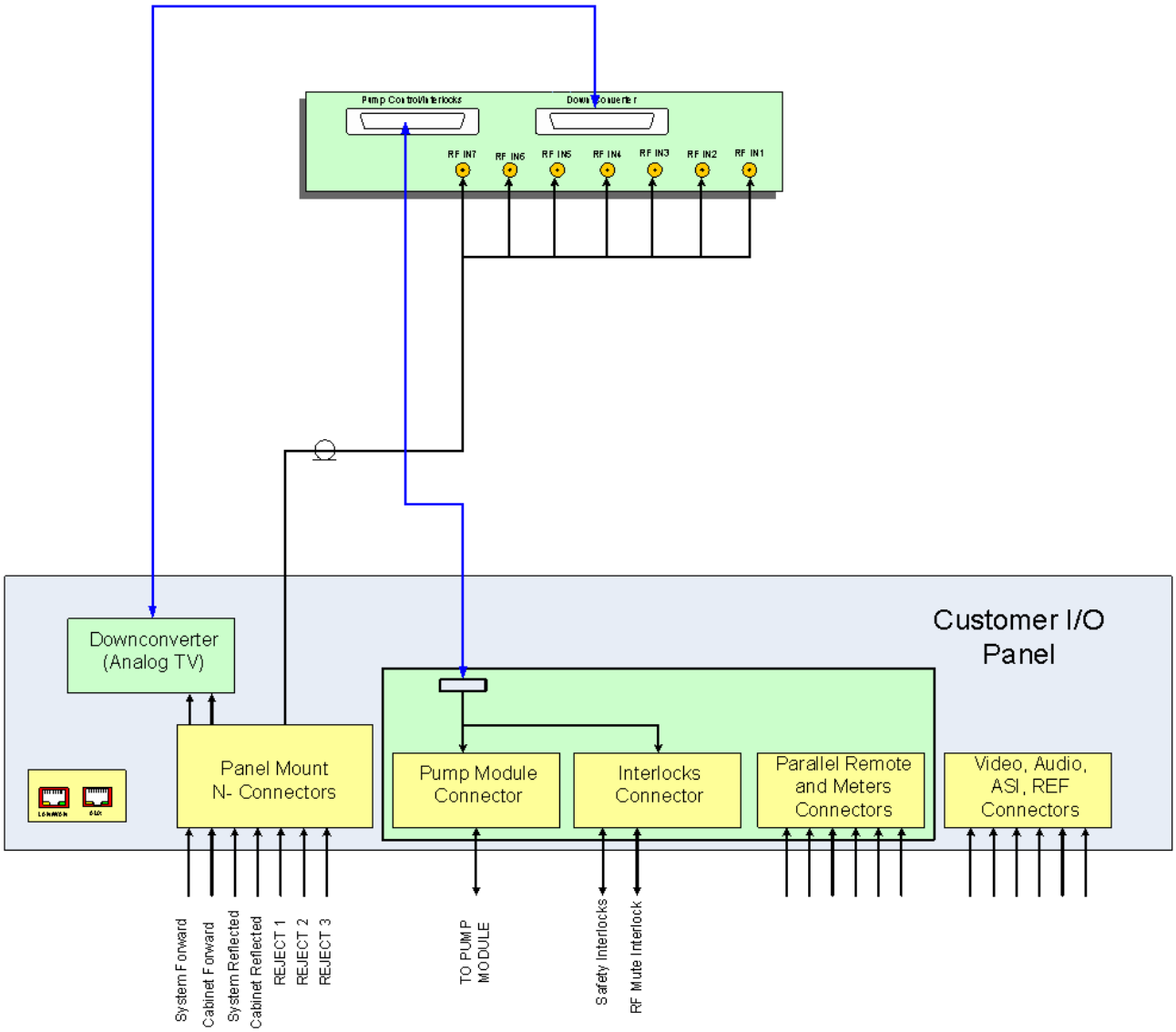

Figure 4-5 RF Detector/Pump Control/Interlocks Card

Table 4-1 RF Detector/Pump Control/ Interlocks Card Connector J3 Pinout

Pin	Signal	Description
1	CABINET_SAFETY_INTLK	Input - Active high, cabinet safety interlock
2	CABINET_RF_MUTE_INTLK	Input - Active high, cabinet RF mute interlock
3	SYSTEM_SAFETY_INTLK	Input - Active high, system safety interlock
4	SYSTEM_RF_MUTE_INTLK	Input - Active high, system RF mute
5	PUMP_ON_CMD	Output - Active high to turn on selected pump
6	PUMP_SWITCH_CMD	Output - Pulsed active high to switch between pumps A and B
7	PUMP_INTLK	Output, active high
8	COOLANT_FAULT	Input - connect to open drain or relay contacts. Active low 20mA sink.
9	COOLANT_WARN	Input - connect to open drain or relay contacts. Active low, 20mA sink.
10	PUMP_A_STATUS	Input - connect to open drain or relay contacts. Active low 20mA sink.
11	PUMP_B_STATUS	Input - connect to open drain or relay contacts. Active low 20mA sink.
12	PUMP_RMT/LOCAL)_STATUS	Input - connect to open drain or relay contacts. Active low 20mA sink. Remote = High, Local = Low
13	EXT_VDD	+12V dc voltage supplied by pump.
14-17	GND	
18-25	GNDB	

The RF detector inputs on the back of the RF Detector/Pump Control/Interlocks card are given in Table 4-2.

Table 4-2 Detector Inputs on RF Detector/Pump Control/Interlocks Card

Pin	Signal	Description
1	NC (analog) CAB FWD (digital)	Not connected for analog applications. Cabinet forward for digital applications.
2	CAB REF	Cabinet reflected sample from directional coupler DC1 at combiner output.
3	NC (analog) SYS FWD (digital)	Not connected for analog applications. System forward for digital applications.
4	SYS REFL	System reflected sample from customer I/O board J16 at top of transmitter.
5	REJ 1	Reject sample from on customer I/O board J19 at top of transmitter.
6	REJ 2	Reject sample from on customer I/O board J20 at top of transmitte.r
7	REJ 3	Reject sample from on customer I/O board J21 at top of transmitter.

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4.4.4.4 PA Interface Card

The PA interface card(s) connects the TCU, Predriver assembly, IPA (driver) and PA backplane boards. The interface features 40 digital outputs/inputs and 24 analog outputs/inputs. A fully populated cabinet will require two PA interface cards, one card per eight PA modules. The PA interface card sends the ON/OFF commands to the PA modules and receives fault information and status from them. Figure 4-6 shows how the PA interface boards connect to the IPA (driver) and PA backplanes.

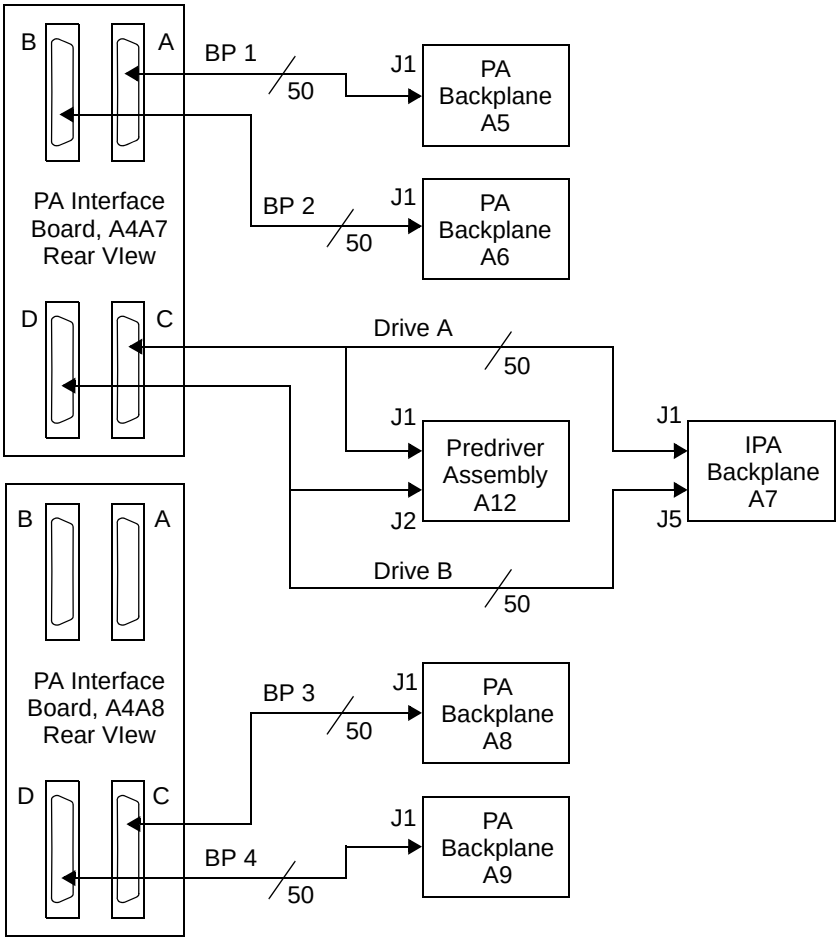

Figure 4-6 PA Interface Card Connection to Backplane Boards

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4.4.4.4.1 Predriver and IPA Drive A and B Busses

The Drive A and Drive B busses provide control and monitoring of the predriver and IPA modules A and B. These busses run from connectors J3A and J3B of PA interface board A4A7 to connectors on the predriver assembly and the IPA backplane board, see Figure 4-6. Table 4-3 provides the connections for these busses.

Table 4-3 Predriver and IPA Drive A and Drive B Control Busses

Predriver Assembly Connectors J1 and J2, and IPA Backplane Connectors J1 and J5							
Pin	**Function**	**Pin**	**Function**	**Pin**	**Function**	**Pin**	**Function**
1	+15V from TCU	14	N C	27	N C	40	Gnd
2	IPA A or B Fault 1	15	N C	28	N C	41	N C
3	IPA A or B Fault 2	16	Gnd	29	N C	42	N C
4	IPA A or B Fault 3	17	IPA A or B On/Off	30	N C	43	Gnd
5	IPA A or B Prsnt	18	Off/On Predrvr A or B	31	Gnd	44	IPA A or B Out Pwr
6	Gnd	19	N C	32	TP1 - IPA A or B	45	IPA A or B Sum Current
7	N C	20	N C	33	Pwr Cntl Predrvr A or B	46	Gnd
8	N C	21	Gnd	34	Gnd	47	Cnt Predriver A or B
9	N C	22	N C	35	Phase Cntl Predrvr A or B	48	In Pwr Predrvr A or B
10	N C	23	N C	36	N C	49	Gnd
11	Gnd	24	N C	37	Gnd	50	N C - Predrvr, Gnd - IPA The Ground serves as an IPA module interlock.
12	N C	25	N C	38	N C		
13	N C	26	Gnd	39	N C		

4.4.4.4.2 PA BP (Backplane) Busses 1 Through 4.

The BP 1 through BP 4 PA backplane busses provide control and monitoring to backplane boards A5, A6, A8, and A9 respectively. They control and monitor the 16 PA modules (four modules for each backplane). These busses run from connectors J2A and J2B of the two PA interface boards A4A7 and A4A8 to connectors on the PA backplanes, see Figure 4-6. Each of these busses have 50 conductors. Table 4-4 provides the connections for these busses.

Table 4-4 PA Backplane Board BP 1 through BP 4 Control Busses

Pin	**Function**	**Pin**	**Function**	**Pin**	**Function**	**Pin**	**Function**
1	VA+	14	PA 3 Fault 3	27	Digital Output 5	40	Gnd
2	PA 1 Fault 1	15	PA 3 Present	28	Digital Output 6	41	PA 2 Output Power
3	PA 1 Fault 2	16	Gnd	29	Digital Output 7	42	PA 2 Sum Current
4	PA 1 Fault 3	17	PA 4 Fault 1	30	Digital Output 8	43	Gnd
5	PA 1 Present	18	PA 41 Fault 2	31	Gnd	44	PA 3 Output Power
6	Gnd	19	PA 4 Fault 3	32	TP3, Analog_Out 1	45	PA 3 Sum Current
7	PA 2 Fault 1	20	PA 4 Present	33	TP43, Analog_Out 2	46	Gnd
8	PA 2 Fault 2	21	Gnd	34	Gnd	47	PA 4 Output Power
9	PA 2 Fault 3	22	PA 1 On/Off	35	TP2, Analog_Out 3	48	PA 4 Sum Current
10	PA 2 Present	23	PA 2 On/Off	36	TP1, Analog_Out 4	49	Gnd
11	Gnd	24	PA 3 On/Off	37	Gnd	50	Gnd
12	PA 3 Fault 1	25	PA 4 On/Off	38	PA 1 Output Power		
13	PA 3 Fault 2	26	Gnd	39	PA 1 Sum Current		

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4.4.4.5 Customer I/O Card

The primary function of the Customer I/O Card is to interface between the internal transmitter control system and all external or peripheral devices.The customer I/O card is located in the TCU and is connected to the Customer I/O board connectors J13 and J14 inside the cabinet top. For more detail on the customer I/O connections which can be found on the customer I/O board on the top of the cabinet refer to section 4.5 on page 4-18 and to sections 2.11 on page 2-20 and 2.18 on page 2-33.

4.4.4.6 Exciter Switcher Card

The exciter switcher card in the main cabinet TCU controls exciter switching with a board mounted relay. It includes 2RMS detectors with adjustable trip points that use EPOTs to monitor exciter power. There are control and status interface connectors J1A and J1B that go to exciters A and B respectively. Table 4-5 shows the signals on the pins of connector J1A. The simplified block diagram for the exciter switcher card is given in Figure 4-7.

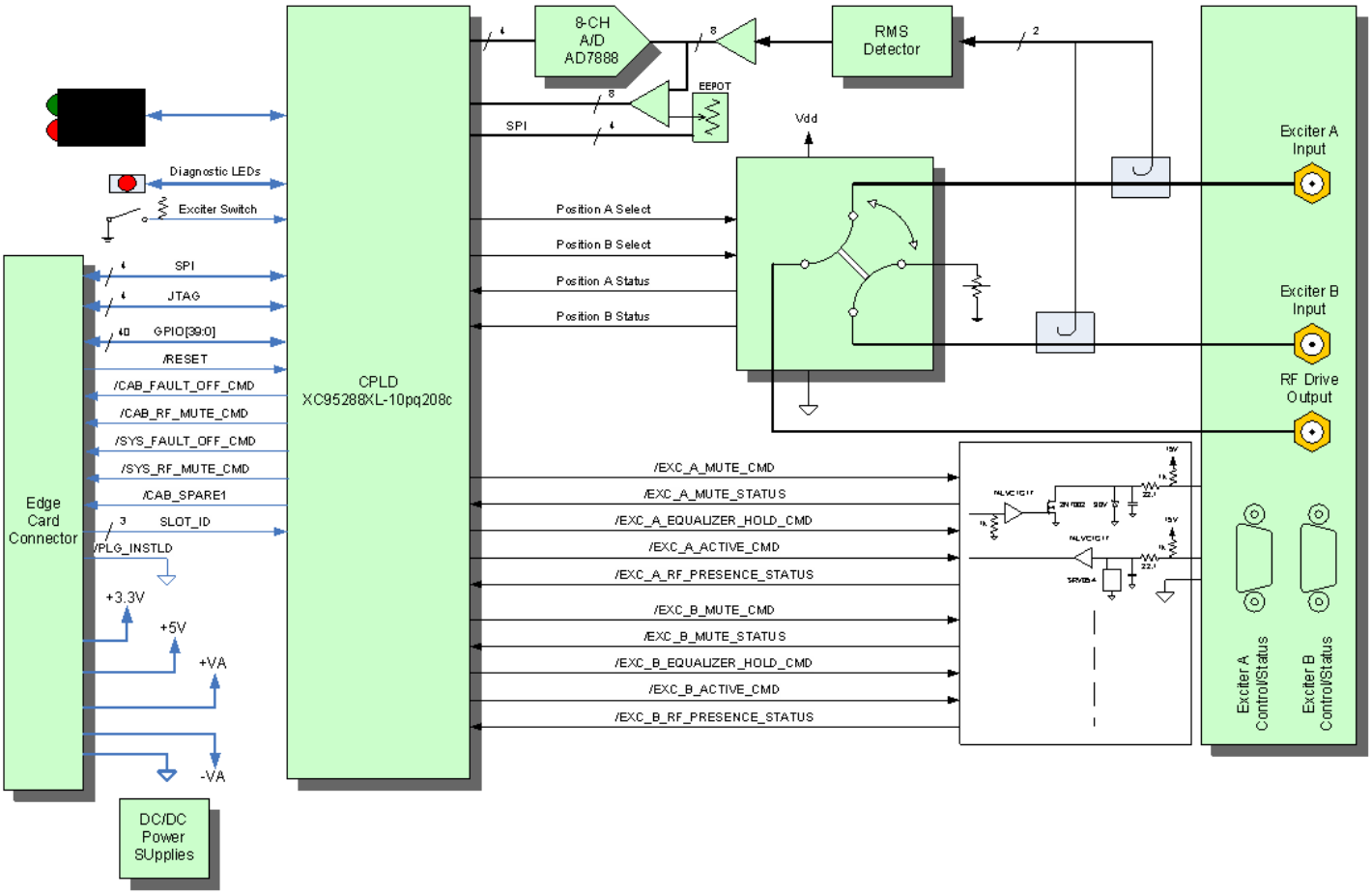

Figure 4-7 Exciter Switcher Block Diagram

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Table 4-5 Exciter A Control/Status Connector J1A on TCU (9 pin female dsub)

Pin	Signal	Description
1	/EXC_A_MUTE_CMD	Open collector output- Exciter A mute command-100mA sink capability @ 0.8Vdc max. 1K ohm pull up to +5V. TVS protection. Active'0' state to command exciter mute.
2	/EXC_A_EQUALIZER_HOLD_CMD	Open collector output- Exciter A equalizer hold command-100mA sink capability @ 0.8Vdc max. 1K ohm pull up to +5V. TVS protection. Active'0' state to command exciter equalizer to hold.
3	/EXC_A_ACTIVE_CMD	Open collector output- Exciter A active command-100mA sink capability @ 0.8Vdc max. 1K ohm pull up to +5V. TVS protection. Active'0' state to command exciter equalizer to "on air".
4	NC	No connection
5	GND	Ground
6	GND	Ground
7	/EXC_A_MUTE_STATUS	CMOS input-Exciter A mute status-'0' on this line indicates exciter is muted. TVS protection. 1K pull up to +5Vdc
8	/EXC_A_RF_PRESENCE_STATUS	CMOS input-Exciter A RF presence status-'0' on this line indicates exciter is present. TVS protection. 1K pull up to +5Vdc.
9	/SUMMARY_FAULT	CMOS input-Exciter A summary fault-'0' on this line indicates exciter has a fault. TVS protection. 1K pull up to +5Vdc.

Table 4-6 Exciter B Control/Status Connector J1B on TCU (9 pin female dsub)

Pin	Signal	Description
1	/EXC_B_MUTE_CMD	Open collector output- Exciter B mute command-100mA sink capability @ 0.8Vdc max. 1K ohm pull up to +5V. TVS protection. Active'0' state to command exciter mute.
2	/EXC_B_EQUALIZER_HOLD_CMD	Open collector output- Exciter B equalizer hold command-100mA sink capability @ 0.8Vdc max. 1K ohm pull up to +5V. TVS protection. Active'0' state to command exciter equalizer to hold.
3	/EXC_B_ACTIVE_CMD	Open collector output- Exciter B active command-100mA sink capability @ 0.8Vdc max. 1K ohm pull up to +5V. TVS protection. Active'0' state to command exciter equalizer to "on air".
4	NC	No connection
5	GND	Ground
6	GND	Ground
7	/EXC_B_MUTE_STATUS	CMOS input-Exciter B mute status-'0' on this line indicates exciter is muted. TVS protection. 1K pull up to +5Vdc
8	/EXC_B_RF_PRESENCE_STATUS	CMOS input-Exciter B RF presence status-'0' on this line indicates exciter is present. TVS protection. 1K pull up to +5Vdc.
9	/SUMMARY_FAULT	CMOS input-Exciter B summary fault-'0' on this line indicates exciter has a fault. TVS protection. 1K pull up to +5Vdc.

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4.4.4.7 PS Monitor Card

The PS monitor card is located in the TCU. The board's primary function is to provide AC power supply monitoring, fuse monitoring, inlet and outlet temperature sensing, coolant flow, leak detection, cooling fan tachometer monitoring, and PA Driver switch interface. A simplified block diagram for the board is given in Figure 4-8.

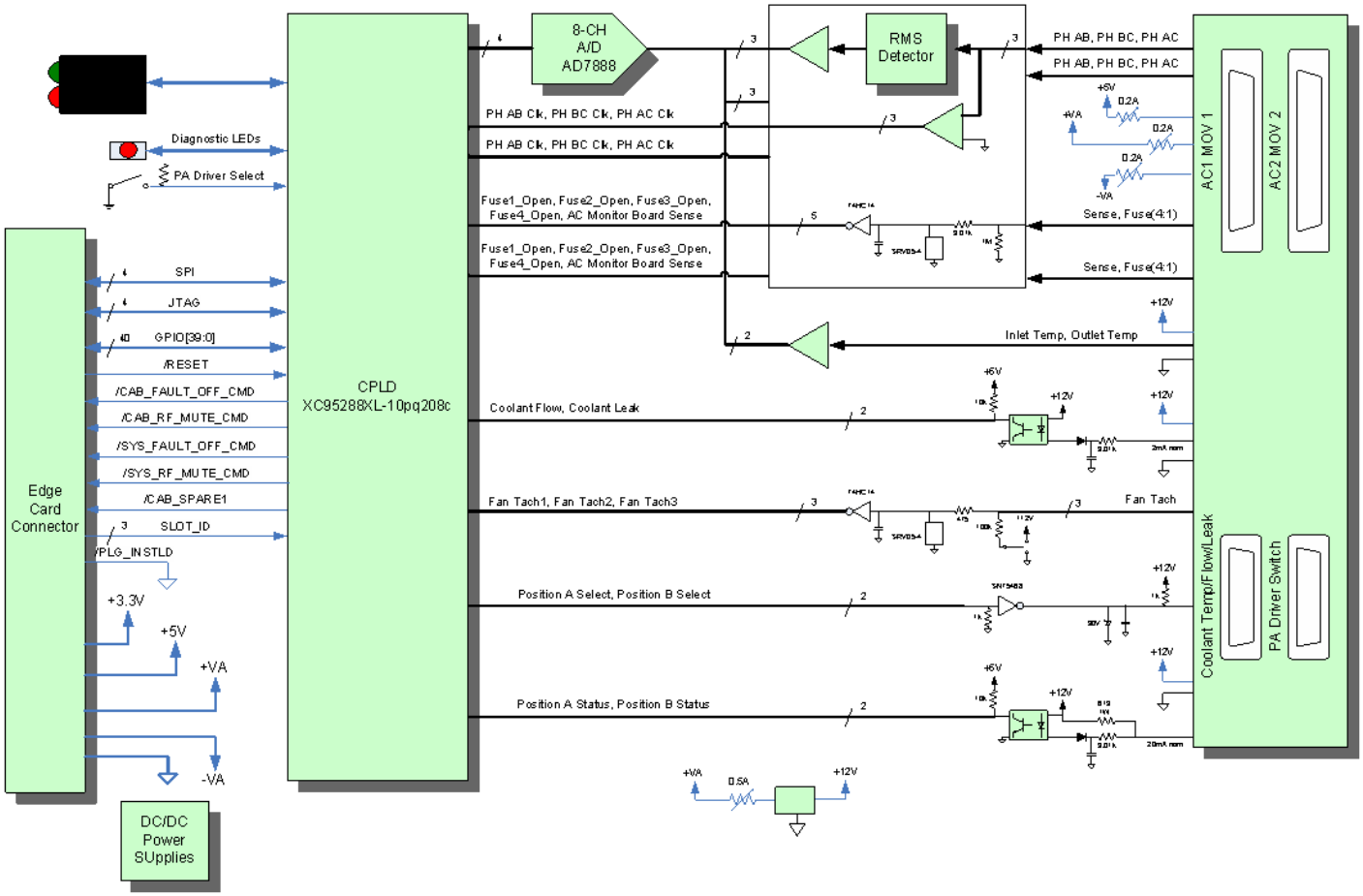

Figure 4-8 PS Monitor Card Block Diagram

Table 4-7 AC1 MOV1 Connector J4A (25 pin stacked female dsub)

Pin	Signal	Description
1	/MOV_SENSE	CMOS input -MOV board sense status-'0' on this line indicates the MOV board is present. TVS protection. 1K pull up to +5Vdc
2	+15Vdc	+15Vdc @ 200mA maximum limited by 0.2A PTC.
3	-15Vdc	-15Vdc @ 200mA maximum limited by 0.2A PTC.
4	PH_AB_SAMPLE	Analog input- AC phase AB sample sine wave input scaled to 2Vrms=245VAC
5	PH_BC_SAMPLE	Analog input- AC phase BC sample sine wave input scaled to 2Vrms=245VAC
6	PH_AC_SAMPLE	Analog input- AC phase AC sample sine wave input scaled to 2Vrms=245VAC
7	FUSE1 Open	CMOS input -MOV board sense status-'1' on this line indicates the fuse is ok. TVS protection. 1M pull down
8	FUSE2 Open	CMOS input -MOV board sense status-'1' on this line indicates the fuse is ok. TVS protection. 1M pull down
9	FUSE3 Open	CMOS input -MOV board sense status-'1' on this line indicates the fuse is ok. TVS protection. 1M pull down
10	FUSE4 Open	CMOS input -MOV board sense status-'1' on this line indicates the fuse is ok. TVS protection. 1M pull down
11-13	NC	Not connected.
14	+5Vdc	+5Vdc @ 200mA maximum limited by 0.2A PTC.
15-23	GND	Ground
24-25	NC	Not connected

Table 4-8 AC2 MOV2 Connector J4B (25 pin stacked female dsub)

Pin	Signal	Description
1	/MOV_SENSE	CMOS input -MOV board sense status-'0' on this line indicates the MOV board is present. TVS protection. 1K pull up to +5Vdc
2	+15Vdc	+15Vdc @ 200mA maximum limited by 0.2A PTC.
3	-15Vdc	-15Vdc @ 200mA maximum limited by 0.2A PTC.
4	PH_AB_SAMPLE	Analog input- AC phase AB sample sine wave input scaled to 2Vrms=245VAC
5	PH_BC_SAMPLE	Analog input- AC phase BC sample sine wave input scaled to 2Vrms=245VAC
6	PH_AC_SAMPLE	Analog input- AC phase AC sample sine wave input scaled to 2Vrms=245VAC
7	FUSE1 Open	CMOS input -MOV board sense status-'1' on this line indicates the fuse is ok. TVS protection. 1M pull down
8	FUSE2 Open	CMOS input -MOV board sense status-'1' on this line indicates the fuse is ok. TVS protection. 1M pull down
9	FUSE3 Open	CMOS input -MOV board sense status-'1' on this line indicates the fuse is ok. TVS protection. 1M pull down
10	FUSE4 Open	CMOS input -MOV board sense status-'1' on this line indicates the fuse is ok. TVS protection. 1M pull down
11-13	NC	Not connected.
14	+5Vdc	+5Vdc @ 200mA maximum limited by 0.2A PTC.
15-23	GND	Ground
24-25	NC	Not connected

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4.4.5 CPLD (Complex Programmable Logic Device)

Each PA (power amplifier) module contains a CPLD (Complex Programmable Logic Device) device. The CPLD is not a microprocessor but is a pre-programmed discrete logic device and therefore very stable and reliable. The CPLD's in the PA modules are responsible for reporting faults back the TCU and also for taking action when the ON/STBY command is issued by the TCU.

4.4.6 Life Support Functions

Life support functions are active when the main control system, controlled by the PCM in the main TCU, is not functioning properly. Life support functions are controlled by the MCM card in the main TCU.

Table 4-9 Life Support Functionality

System Function	Description	Available in Life Support Mode
TX On	Transmitter ON command via front panel or parallel remote interface.	YES
TX Off	Transmitter OFF command via front panel or by parallel remote interface.	YES
Power Raise	Transmitter power raise command via front panel or by parallel remote interface.	YES
Power Lower	Transmitter power lower command via front panel or by parallel remote interface.	YES
Manual Exciter A/B Select	Exciter selection via front panel or by parallel remote interface.	YES
Automatic Exciter Switch over	Automatic exciter switch over of exciters if in AUTO.	YES
Manual Driver A/B Select	Driver selection via front panel or by parallel remote interface.	YES
Automatic Driver Switch over	Automatic driver switch over of Drivers if in Auto.	YES
Manual PA ON/OFF	PA modules can be turned on and off via circuit breaker inside rear of transmitter.	YES
PA Three Strike Sequence	PA module three strike operation required operational PCM.	YES
Manual Pump Switch Over	Pump switch over controlled by push button from pump control card or by parallel remote interface.	YES
Automatic Pump Switch Over	Automatic switch over of pumps if in Auto.	YES
Automatic Transmitter Power Control (ALC)	Transmitter power automatic level control if in AUTO.	YES
VSWR Protection		YES
Fold Back Operation		YES
PA Module Summary Fault Monitoring		YES
PA Module Deep Fault Monitoring		YES
PA Module Meter Readings	Not available due to loss of GUI display.	NO
AC Faults Monitoring		YES
Liquid Inlet/Outlet Temperature Faults		YES
Flow and Temperature Meter Readings	Not available due to loss of GUI display.	NO
Cabinet Summary Fault		YES
Safety Interlocks		YES
RF Mute Interlocks		YES

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Table 4-9 Life Support Functionality

System Function	Description	Available in Life Support Mode
Remote Metering	Not available due to web loss but available on parallel remote.	NO/YES
Basic Parallel Remote Control		YES
Basic Parallel Status Lines		YES
Exciter Parallel Control		YES
Exciter Serial Communications		YES
Web Connectivity		NO

4.4.7 Controller Area Network (CAN) Bus

The Controller Area Network (CAN) bus is a high speed serial communications link which is used between the transmitter control boards for transmission of control, status, fault and metering information. **The CAN bus is distributed as part of the Cabinet Bus and System Bus.** The CAN bus can operate at speeds up to 1Mbps and is designed to operate in hostile industrial environments. The transceivers feature cross wire, loss of ground, over voltage and over temperature protections. A CAN transceiver connected to the CAN bus is considered a Node. There can be up to 110 nodes on the bus with a maximum bus length of about 40 meters for 1Mbps operation.

In a CAN system, data is transmitted and received using message frames. Message frames carry data from a transmitting node to one or more receiving nodes. The messages transmitted from any node on a CAN bus do not contain addresses of either the transmitting node or of any intended receiving node.

Instead, the **content** of each message frame (e.g. ON, OFF, PS 1 Voltage, Coolant Flow OK etc.) is labeled by an identifier that is unique throughout the network. All other nodes on the network receive the message and each performs an acceptance test on the identifier to determine if the message, and thus its content, is relevant to that particular node. If the message is relevant, it will be processed; otherwise it is ignored.

The microprocessors in the MCM and PCM boards have built in CAN controllers which connect to a CAN transceiver and becomes a node on the CAN bus. The CAN transceiver interfaces the single ended CAN controller to the differential CAN bus for high common mode noise immunity, as shown in Figure 4-9. The master and slave TCUs can send and receive information over the differential CAN bus, however the MCM card in the main TCU determines what information is sent and when it is sent for this application.

Note

The MCM card (in the TCU) contains LED's that will flicker on and off at a random rate indicating that there is activity on the CAN bus. If the LED's are off or always on, then the CAN bus is most likely not communicating. The LED pair DS7 and DS8 are for the cabinet CAN bus (Rx & Tx respectively). LED's DS11 & DS12 are indicators for the system CAN bus (Rx & Tx respectively).

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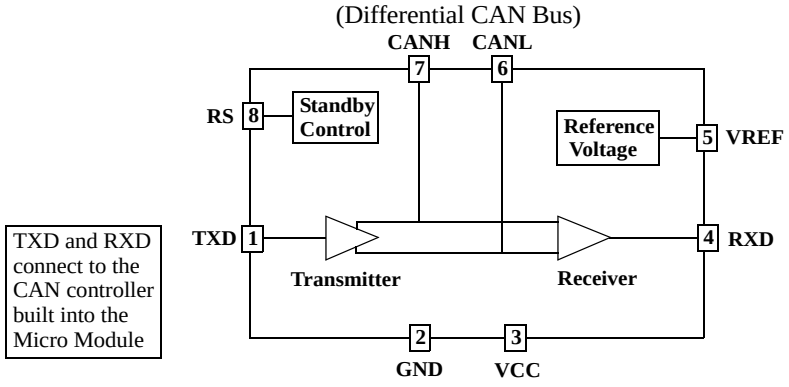

Figure 4-9 CAN Transceiver Diagram

All fault reporting, status and metering information displayed on the GUI is sent on the CAN bus to the MCM. Transmitter control signals are also sent via CAN but are also sent over hardwired parallel control lines.

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4.4.8 System Bus

The *system control bus* is a twenty five conductor ribbon cable which distributes the CAN (Controller Area Network) bus and parallel control lines from the MCM card in cabinet one to other MCM controllers in a multi cabinet system.

If system bus communications with the master TCU (in cabinet 1) are interrupted, the cabinet bus, drive A and B busses, and BP1 through BP4 busses allow each cabinet to operate independently.

The system bus connector J6 (on the rear of the MCM card) has the following pin assignments:

Table 4-10 MCM System Bus Connector

Pin	Signal	Description
1	SYS)_CAN_H	CAN (5V) pass-through
2	/CAB_AC_LOW	3.3V CMOS Input
3	/SYS_OFF_CMD	3.3V CMOS I/O
4	/SYS_RF_MUTE	3.3V CMOS I/O
5	SYS_ALC	0-4.095V Analog I/O
6	SYS_PS_ADJUST	0-4.095V Analog I/O
7	/SYS_FAULT_OFF	3.3V CMOS I/O
8	SYS_SPARE1	3.3V CMOS I/O
9	/SYS_RESTRIKE	3.3V CMOS I/O
10	SYS_SPARE2	3.3V CMOS I/O
11	SYS_CTRLR_OK	3.3V CMOS I/O
12	/SYS_FAULT	3.3V CMOS I/O
13	SYS_SPARE3	3.3V CMOS I/O
14	SYS_CAN_L	CAN (5V) pass through
15-25	GND	

4.4.9 Cabinet Bus

The *cabinet bus* connects the cabinet TCU (MCM card) to the IPA and PA backplanes. The cabinet bus connections are shown in Table 4-11.

Table 4-11 Cabinet Bus Pin Assignments

Cabinet Bus Pins	Function
1 through 6	No Connection
7	PA_voltage_select
8 through 11 & 13	No Connection
12	CAN(H)
14 Through 24	Ground
25	CAN(L)

Pin 7 of the cabinet bus carries the PA_voltage_select signal from the MCM card to the IPA and PA backplanes. Its function is to set the output voltage of the AC to DC converters in the PA (and IPA) modules. Pins 12 & 25 are for the CAN bus which is used for additional exciter communications and N+1 interface.

Table 4-12 gives the control voltage levels and the corresponding PA and IPA module AC to DC converter output voltages.

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Table 4-12 PA Module Power Supply Output Voltage Control

PA_Voltage_ Select Voltage	Power Supply Output Voltage
5.755 Vdc	44Vdc
4.122 Vdc	46 Vdc
2.490 Vdc	48 Vdc
0.875 Vdc	50 Vdc

4.4.10 Parallel Control Lines

The parallel control lines are used for quick actuation of critical functions, such as ON, OFF, RF mute, PS adjust, and Fault Off. These lines are also the backup control lines in life support mode when the PCM (and therefore the system CAN bus) is not operational. The MCM card in each cabinet can independently activate some or all of the parallel control lines to maintain operation and protect the transmitter in case of a fault or other condition that may adversely affect the transmitter. These parallel control signals are duplicated in the CAN messages. The following is a brief explanation of each of the parallel control lines included in the system control bus.

a. SYS_ON_CMD
This command corresponds to the transmitter operator pushing the "ON" button, This signal is high for ON and produced by the MCM card in the TCU.

b. /SYS_OFF_CMD
This command corresponds to the transmitter operator pushing the "OFF" button. The signal is low for OFF and produced by the MCM card in the TCU.

c. /SYS_RESTRIKE
When the transmitter is already turned ON and the operator presses the "ON" button, this line will be pulsed low for a minimum of 100ms. This will cause all controller boards to reset any faults and status and try to return to normal operation. This line is a sense only line for the rest of the control boards.
This command is basically a RESET pulse which will try to turn on any transmitter components which have faulted off due to a critical fault condition. If they are still faulty, this will be detected and the component will simply be shut off again. This will not reset or clear the Fault Log.

d. /SYS_FLT_OFF
This command is initiated whenever a fault occurs that requires all RF to be shut off and the amplifiers to be disabled. This is a latching type signal that requires user input to clear the fault and turn the transmitter back on. This signal is active low. The signal is generated by the MCM in the main cabinet TCU.

e. /SYS_RF_MUTE
The /SYS_RF_MUTE line shuts down all RF output temporarily until the fault condition is cleared. This is a non-latching signal. Non-latching means that if the fault clears the transmitter will resume previous RF output.

f. SYS_PS_ADJUST
The SYS_PS_ADJUST line changes the output of the PA module power supplies depending on modulation mode.

g. /SYS_FAULT

h. SYS_ALC
Automatic Level Control. The ALC signal is used to control the cabinet power output and is normally sent digitally over the CAN bus. This line carries an analog voltage from the MCM to the predriver modules. The analog signal is an alternate version of the digital ALC signal sent over the CAN bus. It is a backup signal only used if the PCM card in main cabinet (cabinet one in multi cabinet systems) fails. If the PCU and it's associated CAN bus is operational, this signal is not used.

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4.5 Customer I/O Board

The customer I/O board is located on top of the main cabinet and provides parallel remote control, status and meter outputs. There are 20 command inputs, 20 status inputs, 8 analog inputs and 8 analog outputs. See Section 2.18 on page 2-33 for additional information and details on the remote control connectors available on the customer I/O board.

Input/Output (I/O) ports on the Customer I/O Board include:

- J1 Pump Module see Section 2.7.6 on page 2-9 and external wiring diagram for connection details.
- J2 Interlocks see Table 2-10 on page 2-20 for connections
- J3 Control 1 see Table 2-12 on page 2-34 for connections
- J4 Control 2 see Table 2-12 on page 2-34 for connections
- J5 Control 3 see Table 2-12 on page 2-34 for connections
- J6 Status 1 see Table 2-13 on page 2-35 for connections
- J7 Status 2 see Table 2-13 on page 2-35 for connections
- J8 Status 3 see Table 2-13 on page 2-35 for connections
- J9 Meters see Table 2-14 on page 2-37
- J10 RF Switch see Table 2-15 on page 2-37

4.6 Transmitter RF System

4.6.1 Apex M2X Exciter(s)

The Maxiva ULX series analog transmitter comes standard with a single M2X exciter. A second standby exciter is available as an option along with an exciter changeover switch card in the TCU. Operation and information about the M2X exciter is contained in the instruction manuals shipped with the exciter. If there are two exciters the output of the exciters are connected to the exciter switch card in the main cabinet TCU. The selected exciter then goes to a two way splitter, then to the pre-drivers. In cases where there is a single exciter it's output goes directly to the pre-drivers via a two way splitter. For additional information on the M2X exciter see the exciter technical manual which ships with each transmitter.

4.6.2 Predriver

The Maxiva ULX predriver provides redundant power and phase adjustment of the RF drive signal for the transmitter. The predriver operates over UHF TV frequency bands IV/V. The unit includes an air cooled 28V 4.5A power supply, phase-n-gain board, RF amplifier and interface board. The predriver is designed to perform following functions:

- Amplify and adjust the power level of the RF signal (max gain 31dB).
- Adjust the phase of the RF signal (range 180°).
- Monitor operating parameters of subassemblies
- Provide connection with TCU via interface board.

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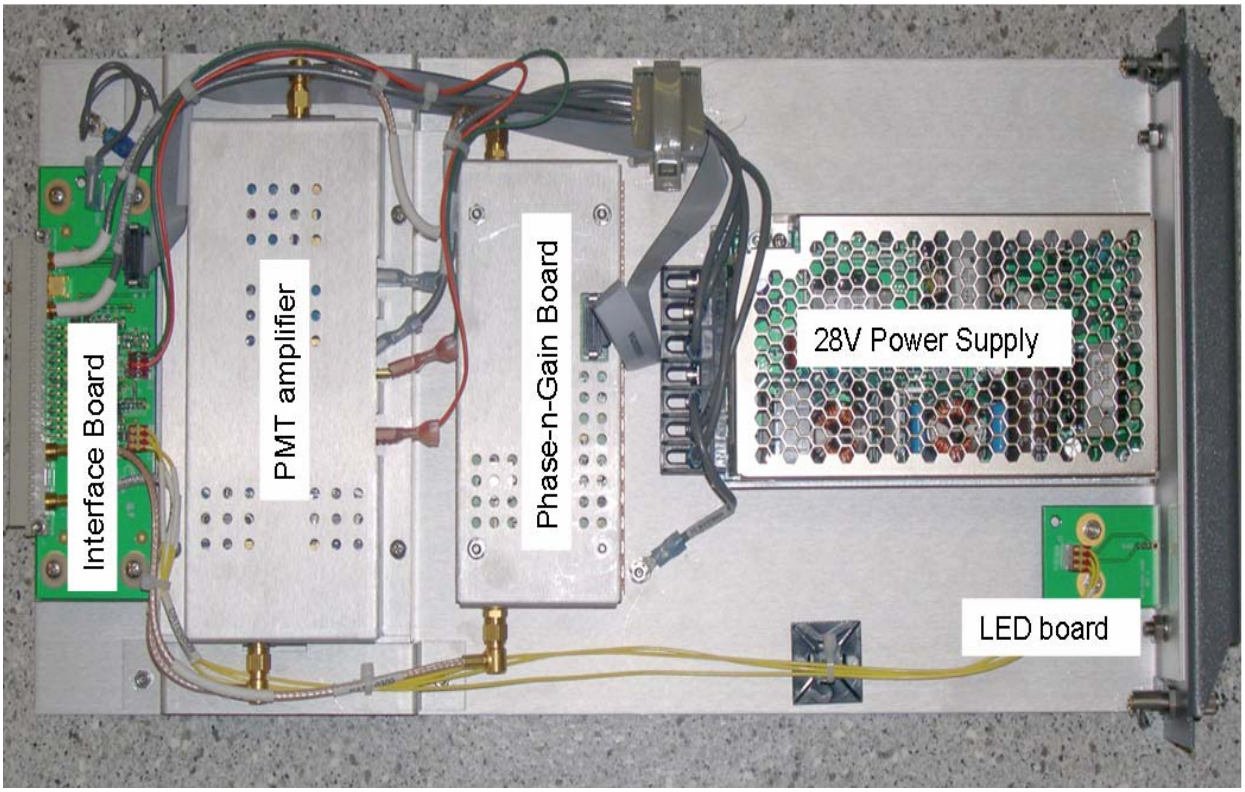

Figure 4-10 Predriver Module Photo (module removed from Predriver assembly)

The predriver assembly holds two predriver modules. The modules are redundant and hot swappable. See photo in Figure 4-10 to aid in identification of predriver module components.

The single rack unit predriver assembly has one RF input and two RF outputs, see Figure 4-11 on page 4-20 for a schematic orientated block diagram of the predriver assembly. It features two predriver trays (modules), each of which drives its own IPA. The RF input to the predriver assembly feeds a two way splitter, the output of which feed the two predriver trays. The assembly is designed so that one predriver tray can be removed for servicing while the transmitter operates from the other predriver tray.

It should be noted here that only one IPA drives the PA modules, the other is terminated in a load. The IPA outputs feed a coax switch, which is controlled by the power supply monitor board in the TCU assembly. This allows either IPA to drive the PA assembly.

The interconnect board is the interface between the transmitter cabinet wiring and each predriver tray. Each predriver tray has a connector, mounted on its interface board, which mates with a connector on the interconnect board. The interface board connects to the four boards of the predriver tray.

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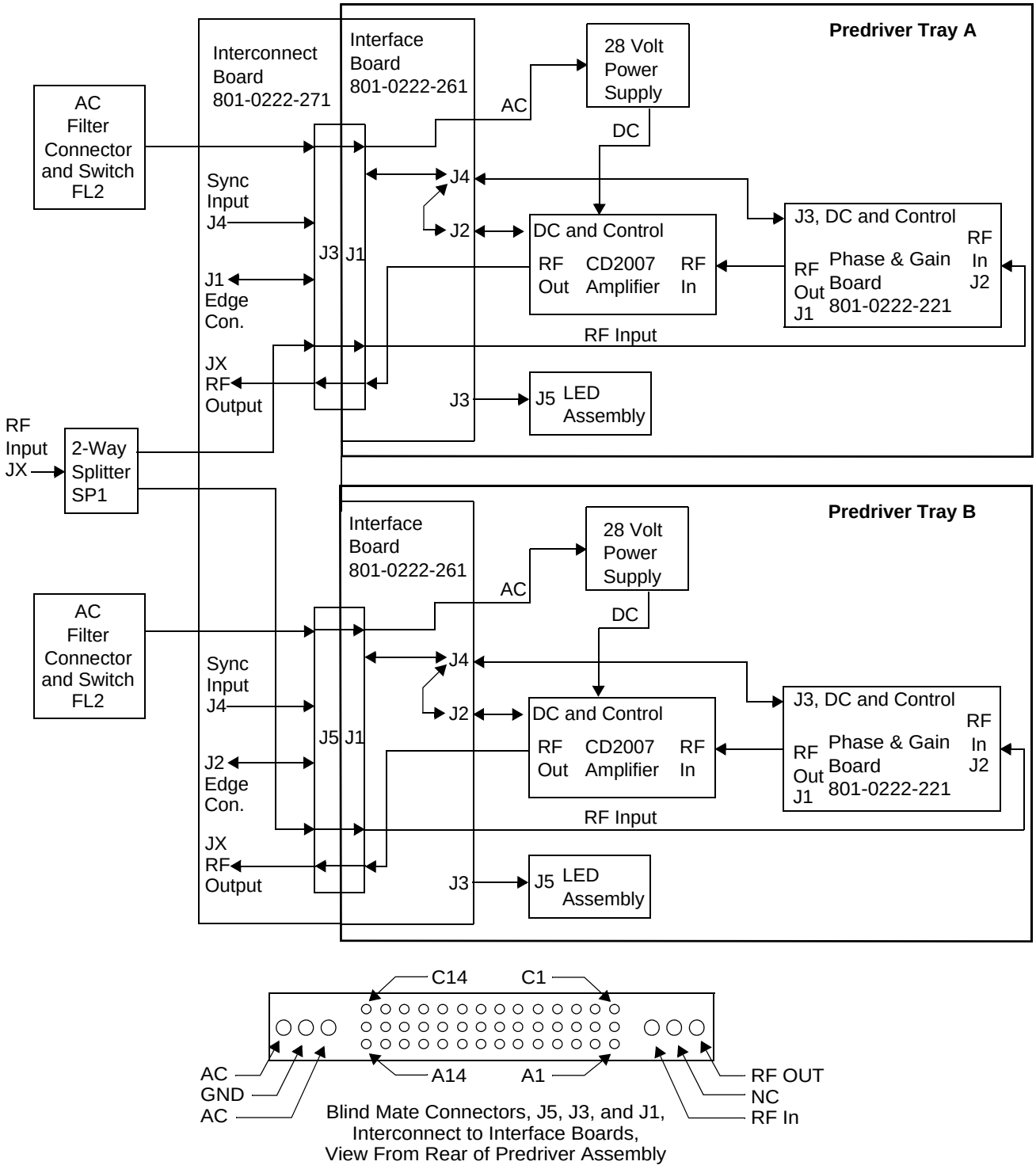

Figure 4-11 Predriver Backplane Diagram

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The CD2007 output amplifier board and the phase and gain board receive their power from the power supply board mounted on the tray. This power supply produces 28 Vdc at 4.5 amps maximum.

The phase and gain board provides a continuously variable phase change of 180 degrees, which is used to combine multiple PA cabinets. It also has an attenuator, driven by the transmitter's ALC (automatic level control) circuit, which has a 0 to 15 dB variable range. The phase and gain board is used by the transmitter to control cabinet power (by driving the PA modules with more or less input power) and cabinet phasing. Figure 4-12 gives a block diagram of the phase and gain board.

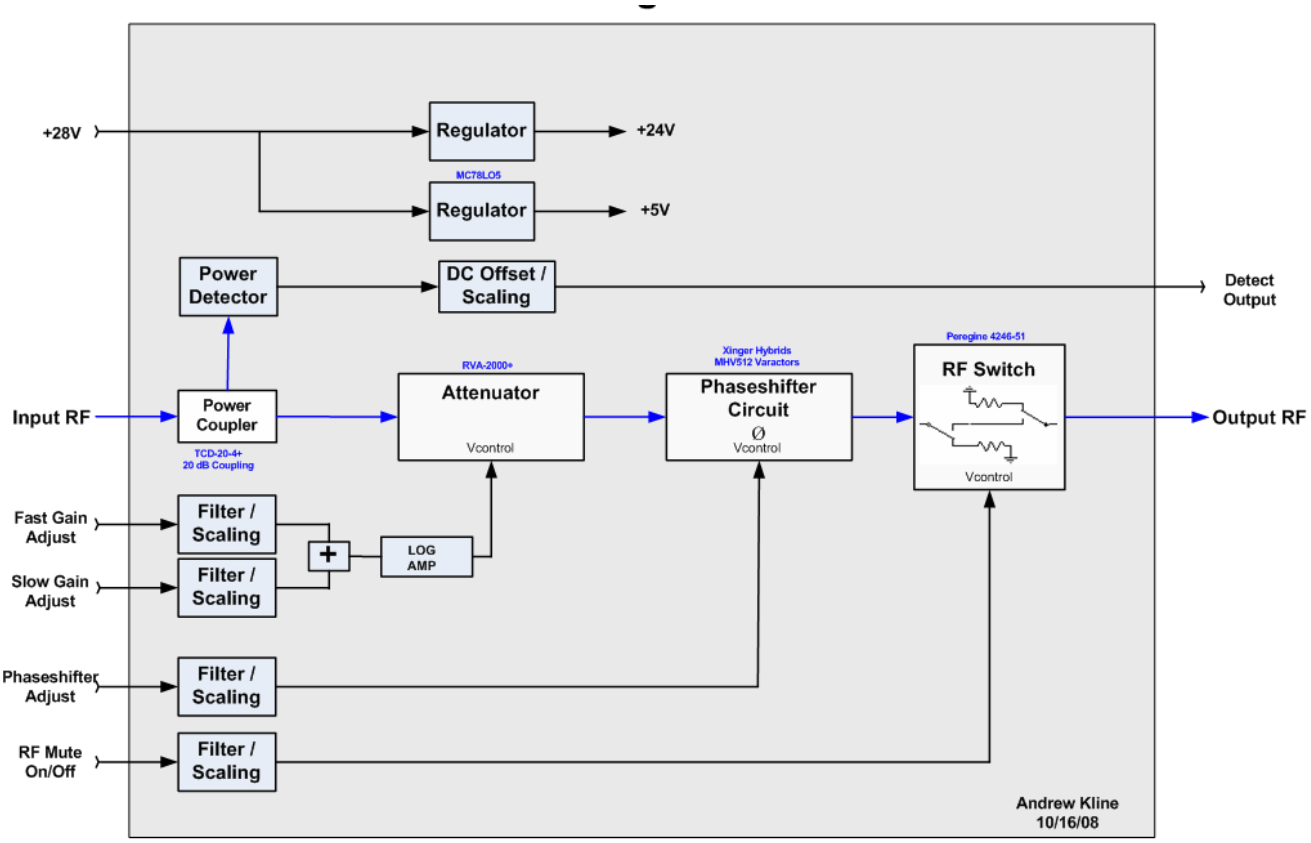

Figure 4-12 Phase and Gain Board Block Diagram

The CD2007 output amplifier has a peak rating of 35 watts and is generally operated over a 0.3 to 4.0 watt average range for digital, to allow adequate peak to average power headroom. In the analog TV mode its output is up to 6 watts peak of sync with 10% aural. At 28 Vdc supply voltage this amplifier requires approximately 5.2 amps to produce 35 watts output. It has an efficiency of 24% at 35 watts output.

The typical gain of the predriver tray is 32 dB, and the gain of the predriver assembly (which includes the 2-way splitter) is 28 dB.

4.6.3 IPA (driver) and PA Module

The purpose of Maxiva ULX PA and IPA (driver) module is to amplify modulated RF signal providing approximately 19 dB gain over TV frequency bands IV/V. The module includes its own power supply section that generates drain bias for RF power generating section of the module. The PA module is designed to be used within terrestrial television standards G, H, I, K, KI, L, M, N with color systems PAL, SECAM or NTSC. The PA module can operate in common amplification mode with single or dual aural sub-carrier present along with the visual amplitude modulated carrier. The PA and IPA (driver) modules can be also used to amplify digitally modulated RF signals, such as COFDM and 8-VSB. The modulation bandwidth is not to exceed 8MHz.

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The PA and IPA (driver) modules are identical in systems with more than 8 PA modules. In transmitters with eight or less PA module the IPAs are modified (simplified). Modified IPA modules cannot be installed in PA module slots due to a pin on the rear of the IPA module (see Figure 1-9 on page 1-10). For additional information. block diagram, and photos of PA module see 1.2.6 on page 1-6. For additional information. block diagram, and photos of modified IPA module see 1.2.7 on page 1-9

A schematic orientated block diagram of the PA module is shown in Figure 4-13 on page 4-23. The Connector I/O board is the connecting link to the PA or IPA backplane board for all connectors except for the RF output connector. See the module photo in Figure 1-7 on page 1-8 to aid in IPA/PA module component identification.

The RF input, signal enters the Connector I/O board through the blind-mate connector J1. It enters the Splitter board through J2, where it is split into four signals, which are the drive signals for the four PA pallets, A13 through A16. The RF signal enters each PA pallet through E1 and the amplifier signal leaves the pallet through E2. From the PA pallets, the four RF signals enter the combiner board via ports 1 through 4. The combined output leaves the combiner board and the PA module through a blind mate RF connector.

Blind mate connector J1 is a combination RF and control connector. A discussion of the connector pinout is included in Section 4.6.3.5 on page 4-27, a drawing of the connector is shown in Figure 4-16 on page 4-27.

Three phase AC power enters the connector I/O board at J1 pins E1-8 through K1-8, then via TB1, TB2, and TB3 to the AC distribution board J10, J11, and J12. In the AC distribution board, a single phase of the three phases of AC input power is applied to each power supply in an arrangement which balances the load between the phases. Three phase AC in 208 to 240 volt delta or 380 to 415 volt wye can be used in these transmitters. Additional information concerning the three phase AC connections is given in Section 4.6.3.1 on page 4-24.

Each power supply provides a DC output voltage which is controlled by the PA_Voltage_Select signal from the MCM (main control module in the TCU) via the cabinet control bus pin 7, see Figure 4-14 on page 4-25 for signal path. This DC voltage, on pin 7 of the cabinet control bus, determines the output voltage of the eight PA module power supplies as indicated in Table 4-14 on page 4-25. Within the PA module, the PA_Voltage_Select signal path is via J1-B5 to J2-8 on the connector I/O board, J4-8 to J1-8 on the splitter board, J1-8 to J2-1 on the monitor board, J9-1 to J1-8 through J8-8 on the AC distribution board, to J1-8 on each power supply board.

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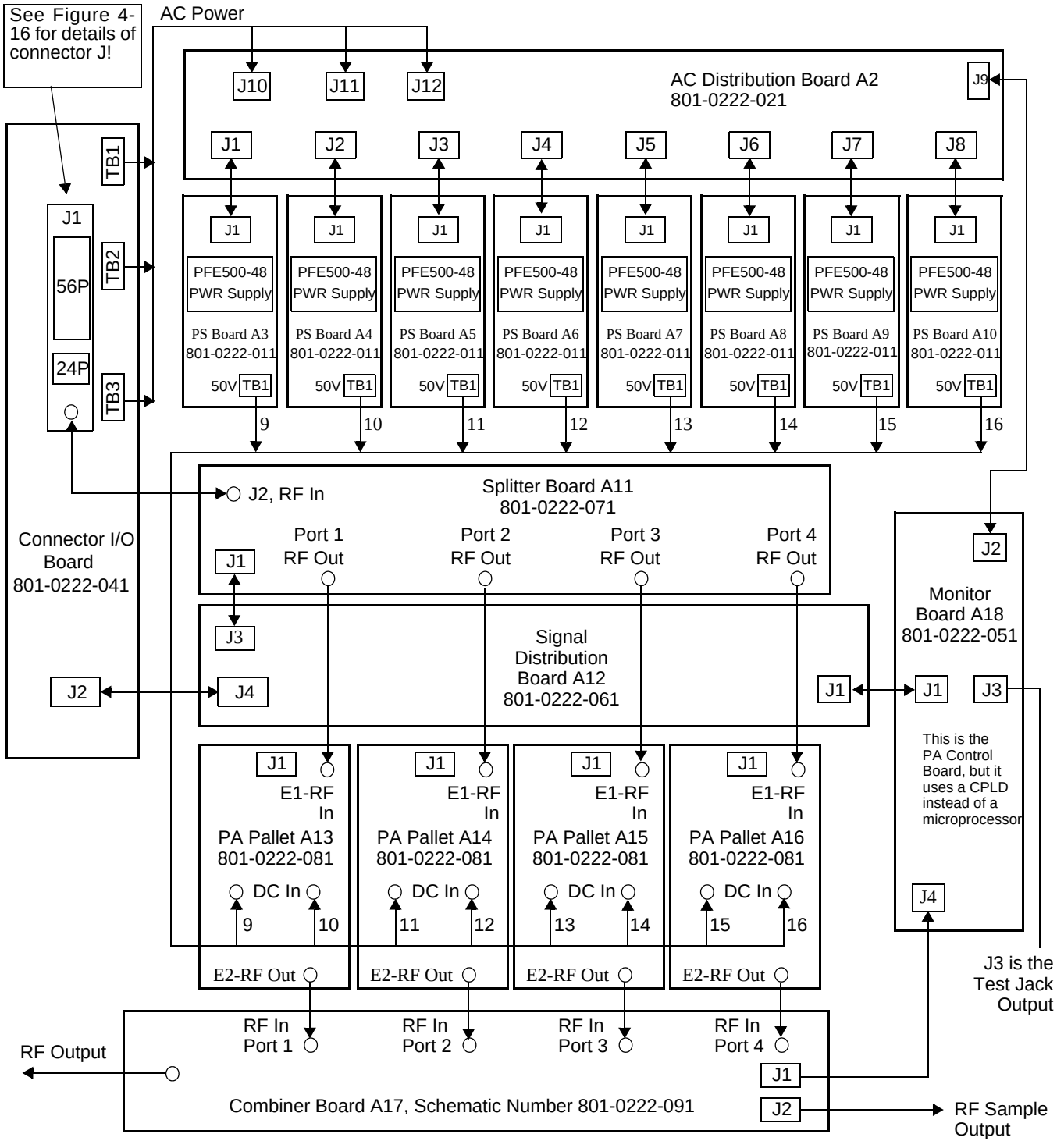

Refer To Drawing 843-5601-012 For Greater Detail

Figure 4-13 PA Module Block Diagram (schematics referenced)

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4.6.3.1 AC Distribution Board

The AC distribution board consists of three identical groups of AC line filtering, two stages of transient protections per filter section. First stage of the protection is formed by a network of MOVs which connects to the AC line filter inputs. The second stage of protection provides a hard voltage limits by using high energy TVS devices, which are connected at the output of each filter section. The maximum peak voltage is limited to 582Vpeak, and is below peak allowed voltage to AC/DC converter interface board.

On board 48V/12V DC/DC converter can provide up to 1.25A of continuous current.

Four wire WYE with neutral power system:

Four wire WYE configuration supports 380/400/415 Vac line to line voltages. Converters are connected between line and neutral, which yields 220/230/240 Vac L-N. Therefore, minimum Line-N voltage is 187Vrms.

Three wire Delta/WYE line to line power system:

Maxiva ULX power amplifier module employs a total of 8 power supply converters. This presents an unbalanced load to the three phase power line grid.

4.6.3.2 AC/DC Converter Interface Board

AC/DC Converter Interface board is a 500W output AC to DC switching power supply. It accepts universal AC input voltage from 85 to 265Vac and the output voltage is adjustable from 44V to 50Vdc. See 4.6.3.3 on page 4-24 for additional information on how PS voltages are set.

Converter is equipped with a power factor correction front end to reduce power line harmonics. Because of the large DC reservoir capacitors connected to its DC bus, a step start resistor is added to limit the inrush current to 7A peak per converter, this is equal to ~1.5x converter's maximum continuous operating current.

The AC/DC Converter Interface PWB is approximately 2.45" x 5.00". All mounting holes are electrically connected to ground. It is a 4 layers board. The AC/DC converter boards are field replaceable. AC/DC converter (power supply) replacement instructions can be found in section 5.7 on page 5-9.

Table 4-13 PS Connector Pin Assignments

Pin	Signal	Description
1	AC1	Input, 3.4A, 240VAC fused at 5A
2	NC	Not connected
3	AC2	Input, 3.4A, 240VAC fused at 5A
4	NC	
5	NC	
6	GND	Ground
7	GND	Ground
8	DC Trim	Input, 6.49K ohms, 0.75VDC to 6.0VDC
9	DC Source	Output, 0.4A, 50VDC
10	DC Sample	Output, 9.09 Ohm, 50VDC

4.6.3.3 PA PS (AC/DC) Voltage Select Path

Each PA and IPA has eight AC/DC converters (power supplies) which supply voltage to the drains each power amplifier FET. Depending on the RF frequency of operation, the power supplies can be set for 44 Vdc, 46 Vdc, 48 Vdc or 50 Vdc. The power supply output voltage select path, from the MCM board in the TCU to each power supply in each PA and IPA module is shown in Figure 4-14 on page 4-25. The PA voltage select path from the MCM board in the TCU to the IPA and PA backplanes, show by the bold lines in Figure 4-14, is carried on pin 7 of the 25 conductor Cabinet Bus. This represents the only use of the cabinet bus in the Maxiva transmitter.

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Table 4-14 PA Module Power Supply Output Voltage Control

PA_Voltage_ Select Voltage	Power Supply Output Voltage
5.755 Vdc	44Vdc
4.122 Vdc	46 Vdc
2.490 Vdc	48 Vdc
0.875 Vdc	50 Vdc

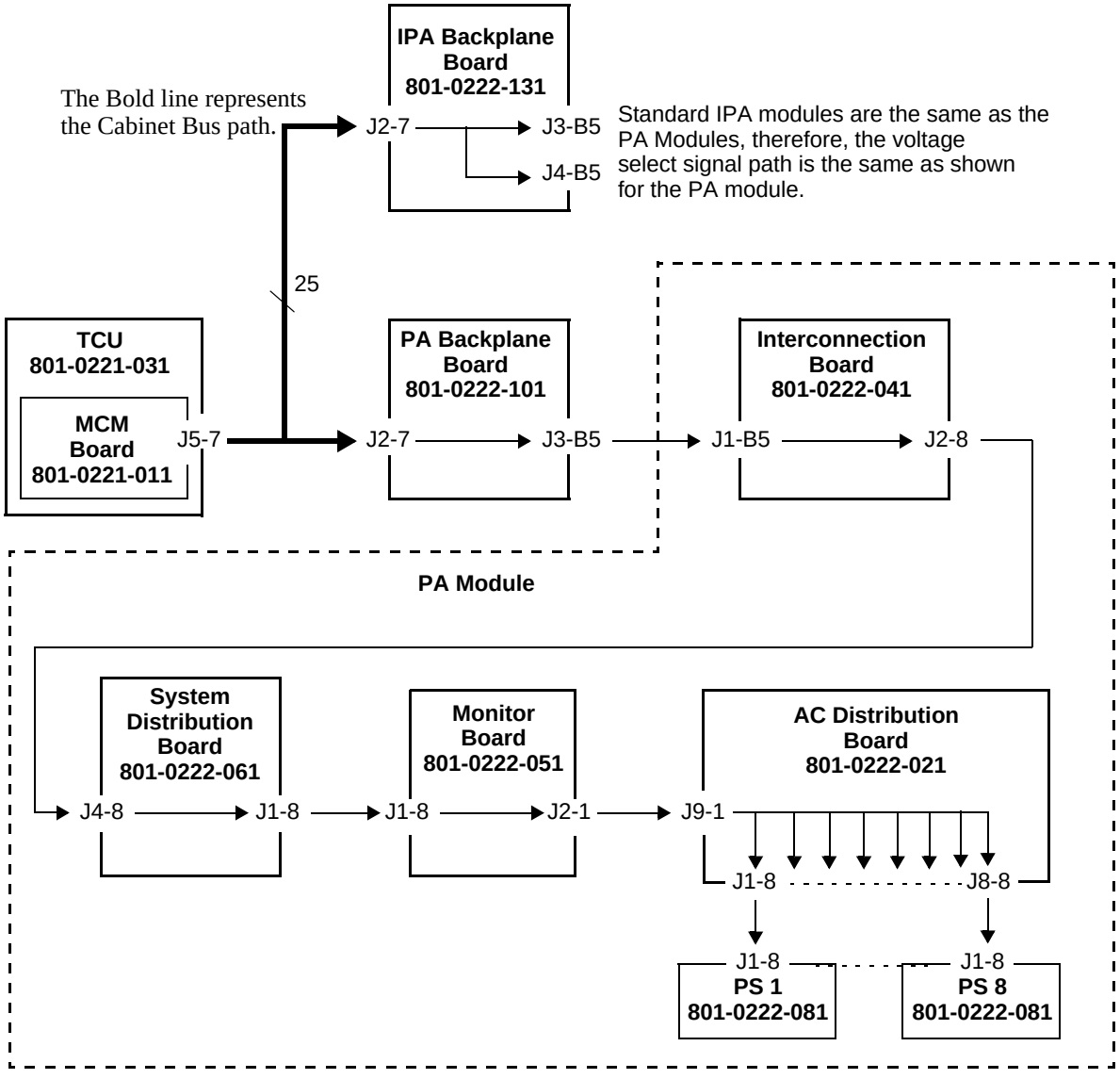

Figure 4-14 Maxiva PA Module Schematic Orientated Block Diagram

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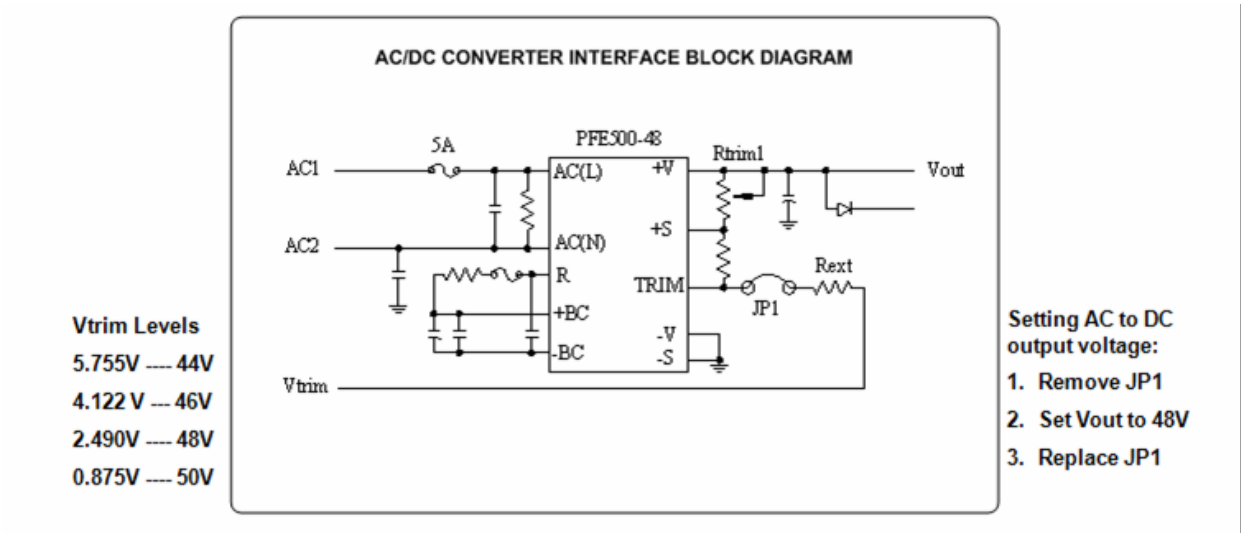

Figure 4-15 AC/DC Converter Interface Block Diagram

4.6.3.4 PA Monitor Board

The PA Monitor Board controls and monitors the PA module's operation. All analog parameters of the power amplifier are monitored and evaluated via the analog comparators to generate the OK/FAULT logic signal, and the signal is sent to a CPLD device to realize a pre-defined control logic algorithm. The fault and warning information is displayed by the red/green LED's in front of the PA, and the fault signal is coded and delivered to the UCP in the Maxiva ULX transmitter via individual separate wires. The overall control logic is done via a CPLD device and there is no microprocessor on board and there is no serial communication designed into the PA monitor board.

Only one fault can be detected at a time. If two or more fault conditions are detected simultaneously only the highest priority fault is shown through the front panel LEDs See Table 4-15 on page 4-27 for a description of the LED indications. The priority table is designed to segregate fault that is most likely responsible for other faults that show up simultaneously. The 3-bit code assigned to the fault with highest priority is sent to the UCP. Following table shows priority assignment and corresponding 3-bit codes.

Priority, Code, Description

- 0, 000,No Fault
- 1, 001,Temperature Fault
- 2, 010, VSWR Fault
- 3, 011, Overdrive Fault
- 4, 100, PS Failure
- 5, 101, MOSFET Fault
- 6, 110, RF IN Low Fault

The Monitor board contains the PA module control circuitry. It is a CPLD controlled circuit, which accepts commands from the TCU and returns status and monitoring signals to the TCU. Within the PA module, the communication path between Monitor board and the TCU is J1 on the Monitor board to J1 on the Signal Distribution board, J4 on the Signal distribution board to J2 on the Connector I/O board, and J2 to J1 on the Connector I/O board. The Monitor board communicates with all of the other boards in the PA module via its connectors J1, J2, and J4. Connector J3 on the Monitor board is a test output used by engineering.

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Table 4-15 PA Module Front panel LED Indications

Index	LED Color	Indication	Description
1	Green	ON-OFF	ON: Green, OFF: None
2	Red	LDMOS Failure	When one or more LD-MOSEFET failed
3	Red	P.S. Failure	When one or more PS failed
4	Red	Temp Fault	When one or more Pallet temp fault
5	Red	VSWR Fault	Reflected Power Overload
6	Red	Power Overload	Input/Output Power Overdrive/ Overload
7	Green	Input Power OK	OK: Green; Input Power Low: Red

4.6.3.5 J1 - PA or IPA Connector I/O Board

Refer to Figure 4-16. The pins of sections A through D of the connector are in horizontal rows of six pins, with pin 1 to the left and pin 6 shown to the right.

The pins of sections A through D are used for control, status, and monitoring.

The pins of Sections E through L are arranged in dual vertical rows four pins each. All eight pins of each section (E through K) are connected together and used for three phase AC input with the eight pins of section L connected to ground.

The three phase AC delta or wye configurations are shown in Table 4-16. If a 208 to 240 volt delta connection is used, connector sections F, H, and K are connected to L2, L3, and L1 respectively. If a 380 to 415 volt wye connection is used, connector sections F, H, and K are connected to the 3 phase neutral. The line or neutral choice is made by connecting jumpers between terminals 1 and 2 for neutral and between 2 and 3 for line inputs in the following listed IPA and PA backplane connectors. In the IPA backplane use TB1 through TB6. In the PA backplane use TB3 through TB8, TB10 through TB12, and TB14 through TB16.

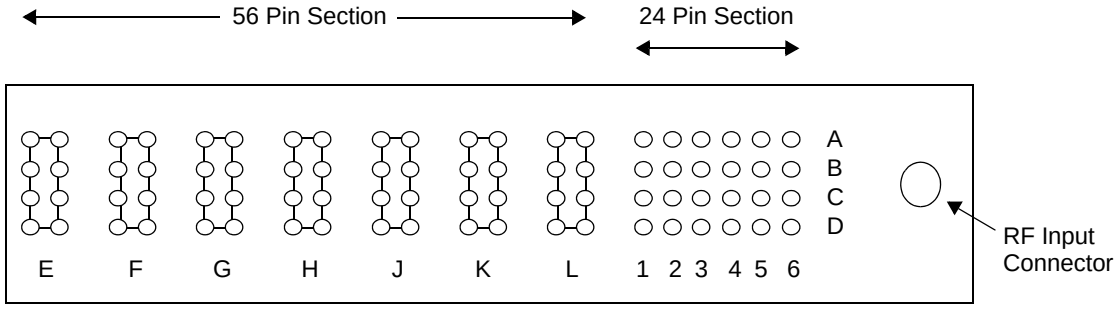

Figure 4-16 IPA (driver) or PA Module, Connector I/O Board, Connector J1 Detail

Table 4-16 Three Phase AC Inputs to Connector J1

Phases	J1 Sections	Output to Connector I/O Board
L1 to L2/N	E to F	TB1
L2 to L3/N	G to H	TB2
L3 to L1/N	J to K	TB3

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4.6.3.6 Signal Distribution Board

Signal Distribution Board serves to route analog and digital control and monitoring data between 4 other board subassemblies, such as:

- Monitor Board
- Four PA Pallets
- I/O Connector Board
- 4-way splitter board

4.6.3.7 PA Module Phase Alignment

PA modules do not require phase alignment to optimize combining of modules. The modules are phase optimized at the factory to produce 90 degrees of phase shift (input to output at 800 MHz) with a tolerance of 5%. The factory phase alignment of each module insures that modules can be used in any position in the transmitter with minimal effects on transmitter operation.

4.6.3.8 PA Module Splitter

The power splitter 9010222071G is used in the Maxiva PA module (p/n 9710040004) to equally divide RF signal that is applied on the input of the splitter between 4 power amplifier pallets. The splitter has a broad band response that covers the entire TV band IV/V frequency range, and requires no tuning. Insertion phase of the signals at each of the outputs is configured to provide minimum loss re-combining by the power combiner. The splitter contains two splitting stages. Each stage equally distributes the input signal between two outputs. Each RF output is isolated from the others to improve amplitude balance between amplifier pallets. The splitter contains envelope detector circuitry that delivers a sample of the down converted signal to the Monitor Board (p/n 901 0222 051G). It contains a directional coupler and a logarithmic amplitude detector.

4.6.3.9 PA Module Pallet Combiner

The power combiner (p/n 901 0222 091G) is used as part of the Maxiva PA module (p/n 971 0040 004) to combine the RF signals from the outputs of the 4 power amplifier pallets, and deliver the resulting signal to the output port. The combiner has a broadband response that covers the entire TV band IV/V, and requires no tuning. The combining of the signals is done in series fashion with the first stage being a 2-way 3dB hybrid, the second stage being a 2-way 4.77dB hybrid, and the 3rd stage being a 2-way 6dB hybrid. Each RF input is isolated from the others by using 50 Ohm 500W reject loads. This allows continuous operation of the PA Module in the event of a PA pallet failure. The combiner contains Forward and Reflected signal directional couplers at the output trace. Two directional couplers have envelope detector circuitry included. The detector circuitry serves to deliver a sample of envelope detected signal to the monitor Board (p/n 9010222051G). The sampled base band signal amplitude indicates power level in dBm. The third directional coupler serves to deliver a scaled down sample of output RF signal to a specially designated coaxial port at the front panel of the PA module.

4.6.3.10 RF Pallets

The PA pallet serves as the single stage of amplification in the Maxiva module. There are 4 PA pallets operating in parallel in this PA module. A simplified diagram of the pallet is given in Figure 4-17. Each pallet has a hybrid splitter on the input side of the FETs. The hybrid divides the RF input signal into two equal parts to feed the two pallet FET's. There is another hybrid at the output of the FET's that is used to combine the amplified outputs. The RF pallets are field replaceable. Replacement instructions can be found in section 5.6 on page 5-8.

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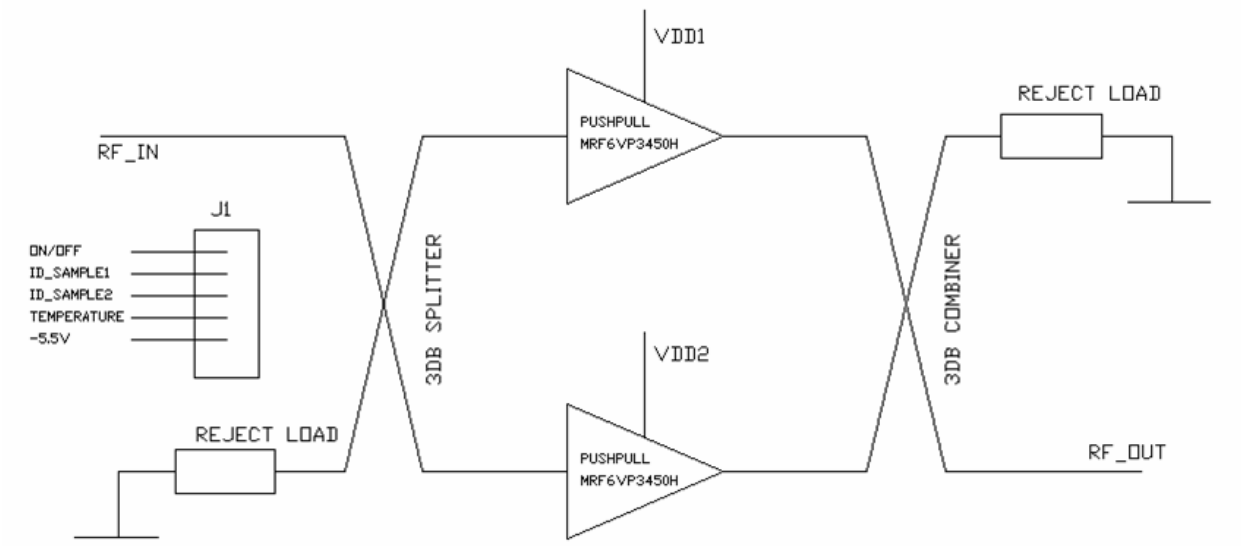

Figure 4-17 PA Pallet Simplified Block Diagram

4.6.3.10.1 FET Bias

The LDMOS FET's used in the Maxiva ULX pallets have been designed by the manufacturer to maintain the factory bias characteristics without the need for re-biasing in the field. The idle current for each FET is set at the factory to approximately 1 amp. Variations between FET idle currents should be less than 10%.

4.6.4 Module Combiner

The module combiner is a compact, water cooled, hybrid combiner optimized to work across the entire UHF frequency band from 470MHz to 860MHz. There are several combiner configurations depending on the number of PA modules used in the cabinet. Figure 1-2 on page 1-3 shows two 8-way PA module combiners (upper and lower with one combiner for each half of the cabinet). The combiner is fed by the PA module outputs.

4.7 Cooling System

Information about the Maxiva ULX cooling system can be found in section 1.2.9 on page 1-11 and in section 2.7 on page 2-4. Detailed theory of operation for the pump module can be found in the HE pump module technical manual 888-2625-001 Section 4.

4.7.1 Heat Exchanger/Pump Module Diagrams

Figure 1-11 is a block diagram that shows the major components in the heat exchanger pump module system. The diagram shows the transmitter as the heat source but does not give details of the plumbing external to the heat exchanger/pump module.

Drawing 843-5607-068 (sheets 1 and 2) shows the dimensions and schematic diagram of the pump module. Information on wiring between the control panel and the transmitter see external wiring diagram 843-5601-705.

4.8 Maxiva 16 Module Transmitter Diagrams

The Maxiva transmitter has many configurations for different power levels. A PA cabinet can hold up to 16 PA modules, and can have up to three cabinets. This section refers to the 16 module transmitter which is housed in the main PA cabinet. When this configuration is understood, the other transmitter configurations can be understood since they are simi liar.

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4.8.1 RF Block Diagram

A schematic orientated block diagram of the Maxiva 16 Module transmitter is shown in Figure 4-18 on page 4-31. The exciter switcher (located in the TCU assembly) selects one exciter for on the air, the other one is connected to a load. Following the exciter switcher is a three way splitter, which provides RF drive for up to three PA cabinets. From the three way splitter, the RF goes to the predriver assembly.

Note

The IPA and PA modules are the same if the transmitter cabinet has more than 8 PA modules. A modified IPA module is used in systems that have less than 8 PA modules. Refer to 1.2.7 on page 1-9 for more information on modified IPA modules.The predriver assembly features an RF splitter and two predriver modules. It therefore has one input and three outputs. The predriver assembly is discussed in greater detail 4.6.2 on page 4-18, and its block diagram is shown in Figure 4-11, on page -20.

The two RF output signals from the predriver are applied to the IPA backplane, where they drive two IPA modules. The two IPA output are applied to the RF drive switch, where the output from one IPA drives the PA modules and the other is sent to a test load.

The on the air IPA output drives a two way splitter, with each of its outputs driving an eight way splitter. Each of these 16 RF outputs are used to drive the 16 PA modules.

The PA modules are inserted into mating connectors on back plane modules. Each backplane module will hold four PA modules, therefore, four PA backplanes are required to house the 16 PA modules.

The PA (and IPA) backplanes are interfaces which supply each PA (or IPA) module with the following:

- Three phase AC power to feed the eight AC to DC converters within each PA module. These converters supply the DC power to the four PA pallets within each PA module.
- RF drive.
- Control and monitoring signals.
- Sync, required for analog TV transmitters only.

The outputs from the PA modules are combined as follows:

- PA Slots 1 through 8 are combined in 8-Way combiner A13.
- PA Slots 11 through 18 are combined in 8-Way combiner A12.
- The outputs of the two 8-Way combiners are joined in 2-Way combiner A14.

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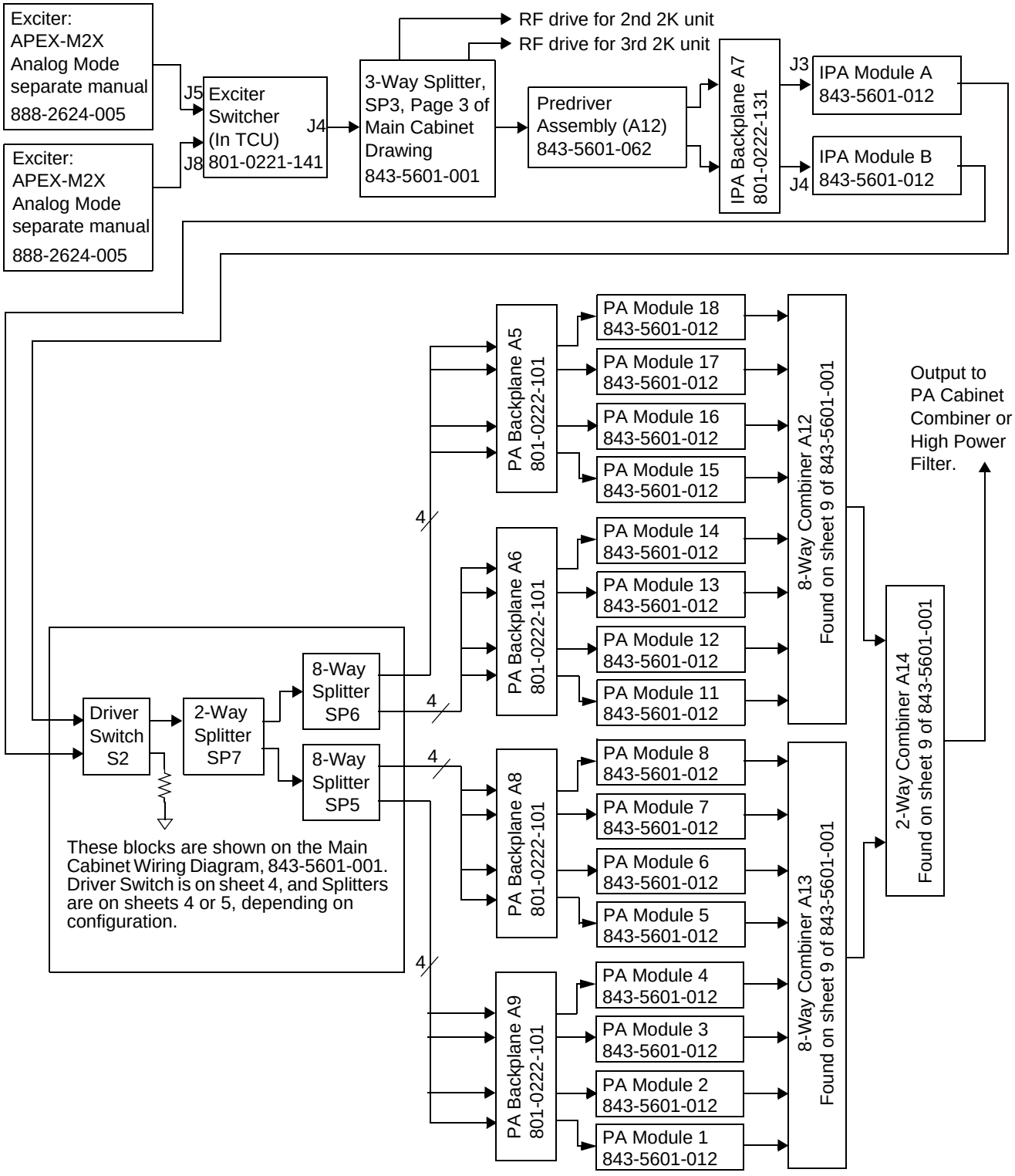

Figure 4-18 Maxiva 16 Module Transmitter Schematic Orientated Block Diagram

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Section-5 Maintenance 5

5.1 Introduction

This section contains all of the maintenance and alignment procedures for the Maxiva ULX Series UHF transmitter. This includes routine maintenance, PA module replacement, PA module repair, transmitter calibration and PC board replacement procedures.

5.2 PA Module Removal and Replacement

Caution

TOXIC BERYLLIUM
SOME COMPONENTS IN THE MODULE CONTAIN TOXIC BERYLLIUM. THIS LIMITS MODULE REPAIR TO A MODULAR LEVEL CONSISTING OF PALLETS AND PC BOARDS ONLY.

HOT SURFACE
THE MAXIVA PA MODULES ARE DESIGNED TO HANDLE VERY HIGH TEMPERATURES AND MAY BE EXTREMELY HOT, UP TO 90^{O} F (32^{O} C) ABOVE ROOM TEMPERATURE. DO NOT TOUCH THE MODULES WITH BARE HANDS AFTER THE TRANSMITTER HAS BEEN RUNNING, ESPECIALLY IN HIGH AMBIENT TEMPERATURE ENVIRONMENTS. SPECIAL GLOVES CAN BE OBTAINED FROM HARRIS, PART #0990006483 OR GRAINGER ITEM #4JF36. BEFORE MODULE REMOVAL ALLOW THE MODULES TO COOL IN THE RACK FOR 30 SECONDS AFTER TURNING THEM OFF WITH THE CIRCUIT BREAKER.

HEAVY WEIGHT
THE PA MODULE WEIGHS APPROXIMATELY 22KG AND CAN BE AWKWARD TO HANDLE. USE PROPER LIFTING TECHNIQUES WHEN REMOVING AND REPLACING PA MODULES.

Caution

RADIO FREQUENCY HAZARD. *DO NOT ATTEMPT TO OPERATE THE PA MODULE WITH THE COVER REMOVED.*

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5.2.1 PA Slot Locations

The number and location of PA modules will vary depending on transmitter model. The following table outlines the slots that contain PA modules in various configurations.

Table 5-1 PA Slot Allocations for Single Cabinet Models

Slot No.	16PA Models	12 PA Models	10 PA Models	8 PA Models	6 PA Models	4 PA Models	3 PA Models	2 PA Models
18	PA	PA	PA	x	x	x	x	x
17	PA	PA	PA	x	x	x	x	x
16	PA	PA	PA	x	x	x	x	x
15	PA	PA	PA	x	x	x	x	x
14	PA	PA	PA	x	x	x	x	x
13	PA	PA	PA	x	x	x	x	x
12	PA	x	x	x	x	x	x	x
11	PA	x	x	x	x	x	x	x
10	IPA-A	IPA-A	IPA-A	IPA-A	IPA-A	IPA-A	IPA-A	IPA-A
9	IPA-B	IPA-B	IPA-B	IPA-B	IPA-B	IPA-B	IPA-B	IPA-B
8	PA	PA	PA	PA	PA	PA	PA1	PA
7	PA	PA	PA	PA	PA	PA	PA2	PA
6	PA	PA	PA	PA	PA	PA	PA3	x
5	PA	PA	PA	PA	PA	PA	x	x
4	PA	PA	x	PA	PA	x	x	x
3	PA	PA	x	PA	PA	x	x	x
2	PA	x	x	PA	x	x	x	x
1	PA	x	x	PA	x	x	x	x

Note: PA indicates that a module is present in the slot for the noted configuration. The Slot No. identifies the PA as it is displayed on the GUI screen.

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5.2.2 PA Module Removal

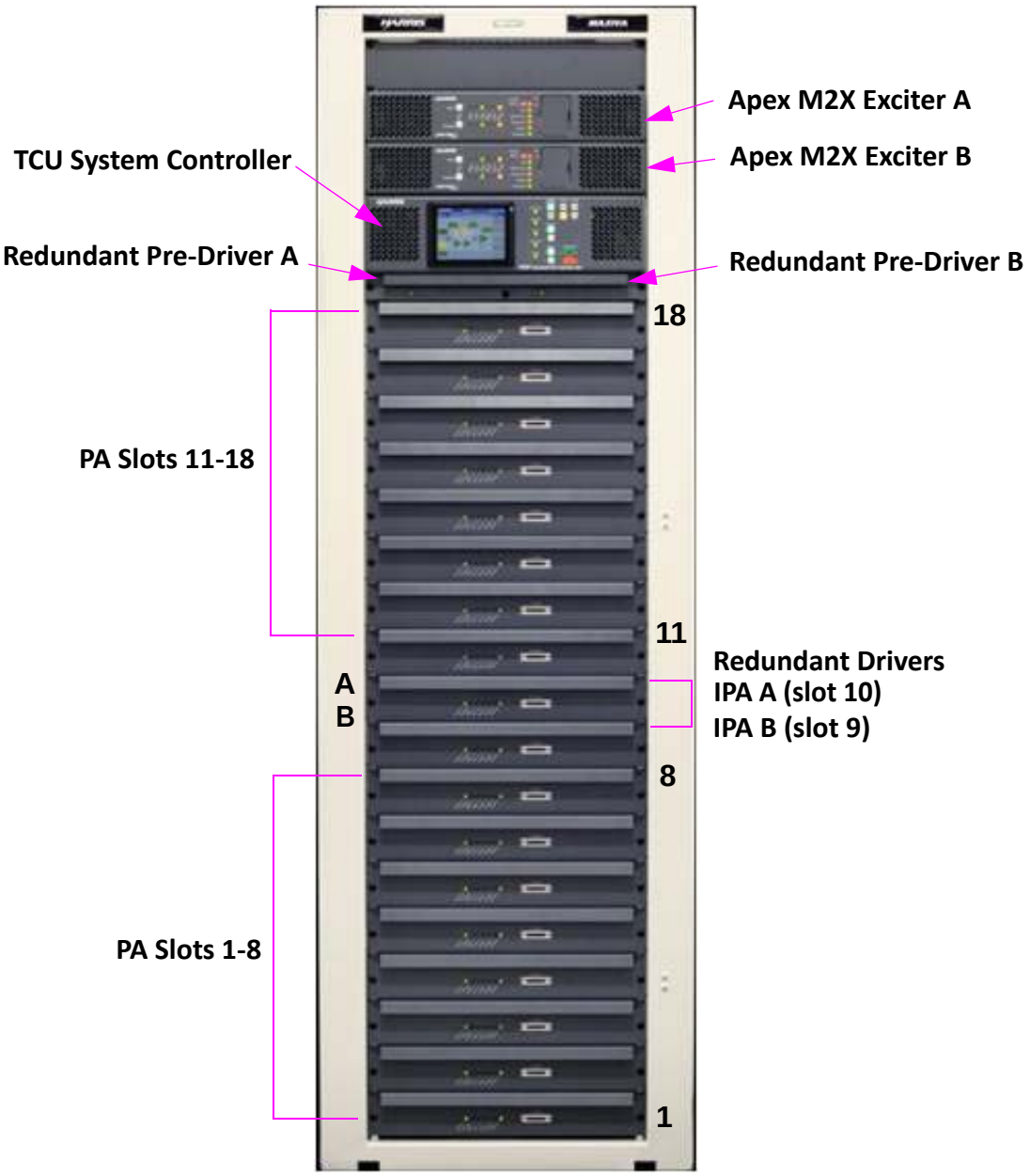

Figure 5-1 PA Module Location

See Figure 5-1 to identify module numbers and their locations in the cabinet. PA and IPA (driver) modules can be removed (or installed) while the transmitter is operating, but the following steps should be followed:

STEP 1 **Prepare a clear path to a location to place the module once it has been removed.**

STEP 2 **Open the rear door.**

STEP 3 **Turn off corresponding PA module circuit breaker on the left rear side of the cabinet.**

Caution

THE PA MODULES MAY BE HOT. ALLOW THE MODULE TO COOL BEFORE REMOVAL.

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STEP 4 **Wait 30 seconds for module to cool.**

STEP 5 **Use a screwdriver (Phillips) to loosen and remove the screws that hold the module in the rack. There is one screw on each side of the module.**

STEP 6 **Pull the module halfway out of the rack, then reposition hands to the sides of the module to better support the weight (22 kg). Remove the module from the rack.**

STEP 7 **End of procedure.**

Caution

DO NOT LET THE MODULE SWING DOWN WHEN PULLING THE MODULE OUT OF THE RACK. THIS COULD CAUSE SEVERE DAMAGE TO THE CONNECTORS ON THE BACK OF THE MODULE.

5.2.3 PA Module Installation

STEP 1 **Inspect the connectors on the rear of the module to be sure there is no damage to the liquid connectors or to the electrical connectors.**

STEP 2 **Inspect the connectors inside the rack to confirm there is no blockage and no damage to the liquid or electrical connectors.**

STEP 3 **Check to be sure that the PA module circuit breaker has been turned off.**

STEP 4 **Slide the PA module gently into the rack until contact is made with the mating connectors.**

STEP 5 **Push evenly on the front of front of the module with a slight side to side motion to help align the mating connectors.**

STEP 6 **Use firm, moderate pressure to fully seat the module.**

If the module fails to seat with moderate pressure do not force the module into the rack. Remove the module and inspect for interference.

Note

In some cases it has been noted that it can be difficult to reinsert a hot PA module. If the connection is difficult (module doesn't seat fully with moderate pressure) simply allow the module to cool sufficiently before reinserting.

Check the coolant connectors on the back of the PA module and on the coolant manifold. The manifold connector has an O-ring seal (Figure 5-2) which must be in good condition to prevent leaks. If there is evidence of a mechanical interference or misalignment of the coolant connectors on all the modules then a rack re-alignment may be required. This may also be required if a manifold is replaced. The rack realignment helps align the coolant connectors in the manifold with the coolant connectors on the PA modules. If rack alignment is needed refer to 5.2.5 on page 5-5.

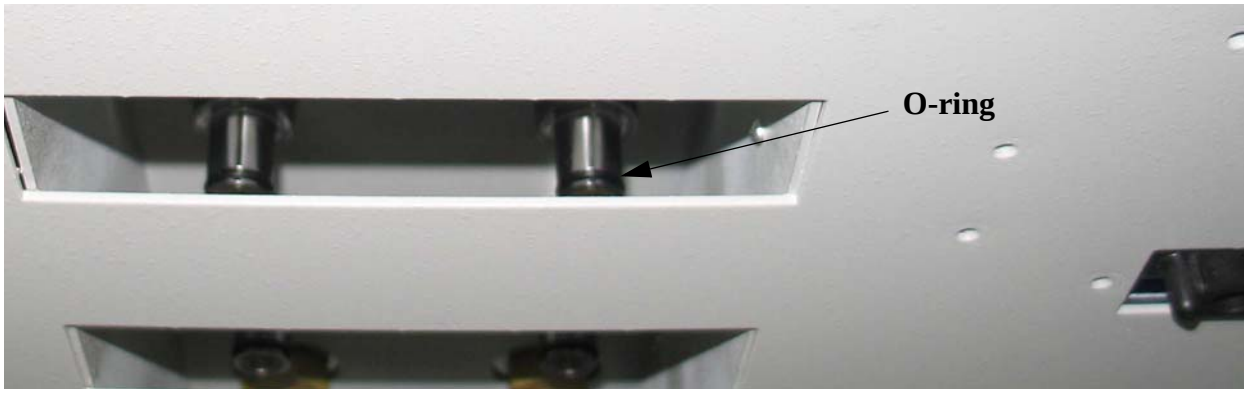

Figure 5-2 Manifold Coolant Connector O-ring

STEP 7 **Install the hold down screws and hand tighten.**

STEP 8 **Turn on the module circuit breaker.**

STEP 9 **Press the transmitter ON button to reactivate all modules that are off.**

STEP 10 **End of procedure.**

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5.2.4 Operation With Inoperative PA Modules

The PA module reject loads, located inside the module combiner, are sized with enough margin to allow operation under any imbalance condition that may be encountered. As long as one module is installed and operational the transmitter will continue to produce RF power but at reduced levels (depending on how many modules are removed).

5.2.5 PA Module/Rack Alignment

If difficulty installing modules is encountered and misalignment of the rack is encountered an alignment of the rack may be needed. The following steps outline the alignment procedure:

STEP 1 **Disconnect power from transmitter. Turn off breakers AC1 and AC2 on the cabinet being aligned.**

STEP 2 **Drain system of coolant.**

STEP 3 **Remove all PA and IPA modules from the rack half being aligned.**

STEP 4 **Loosen manifold clamps (bolts) for the section of the rack being aligned. The clamps are shown in Figure 5-3.**

Note

If both halves of the rack need alignment start with alignment of the bottom half first. Align the top half second.

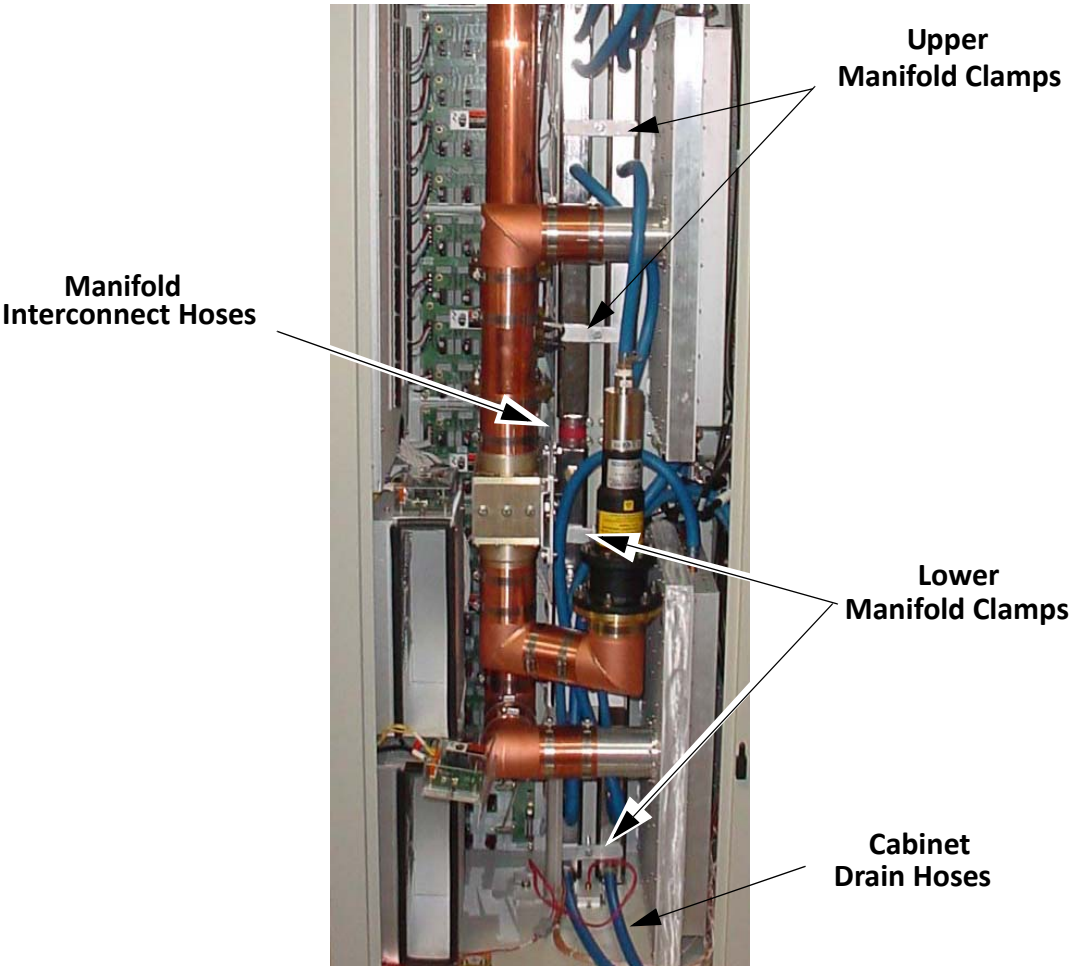

Figure 5-3 PA Module/Rack Alignment

STEP 5 **Loosen hoses between upper and lower manifolds (If more than 8 PA's).**

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Note

The system was drained to avoid leaking at this connection when the clamp is loosened. Loosening the clamp allows the upper and lower manifolds to move relative to each other.

STEP 6 **Using the top and bottom modules in each half as alignment fixtures, place a 0.02"-0.03" thick shim on the cabinet PA shelf guides for a top and bottom module. Carefully insert the top and bottom modules (in the section being aligned) and insure shim is captured between the module cold plate (bottom) edge notch and the cabinet shelf**

Note

The shims position the module slightly higher than normal. This insures that after alignment the module can slide up slightly and onto the manifold connector. This is done to insure that the manifold connectors are a little higher than the module connectors.

STEP 7 **Insert the module slowly and carefully until fully inserted onto the manifold connectors.**

Note

The manifold may have to be moved slightly to allow proper alignment between module connectors and manifold connectors. Do not aggressively insert or damage to the connectors may result.

STEP 8 **Once the two modules are fully inserted (and shims are in place) and seated on the RF connector, two fluid connectors, AC/control connector and alignment pin then tighten the manifold bolts.**

STEP 9 **Repeat procedure on other manifold as applicable.**

STEP 10 **Tighten all hose clamps and hardware loosened in previous steps.**

STEP 11 **Remove alignment modules and shims.**

STEP 12 **Install all PA and IPA modules.**

STEP 13 **Recharge system with coolant.**

STEP 14 **Turn on AC power and restore transmitter to normal operation.**

STEP 15 **End of procedure.**

5.3 PA Module Bias

Re-bias of the PA modules is not required on the Maxiva ULX series transmitters.

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5.4 PA Module Phasing

Phasing of the PA modules is tightly controlled at the factory. No phasing of the modules is required in the field. PA modules and IPA (driver modules, used in transmitter cabinets with 10 to 16 PA modules) can be used in any location without re-phasing. Modified IPA modules, used in PA cabinets with 8 or fewer PA modules, do not require phasing either but can only be used in IPA module slots.

Note

Phasing between cabinets is required to minimize cabinet combiner reject power and it is accomplished via the GUI screen. Cabinet phase and gain is controlled by adjusting the relative phase and RF output levels of each cabinet using the preamplifiers. See Section 3.7.2 on page 3-18 and Figure 3-18 on page 3-18 to view adjustment screen.

5.5 PA & IPA Module Component ID

Before attempting PA or IPA module repairs in the field it is important to properly identify the faulty components.

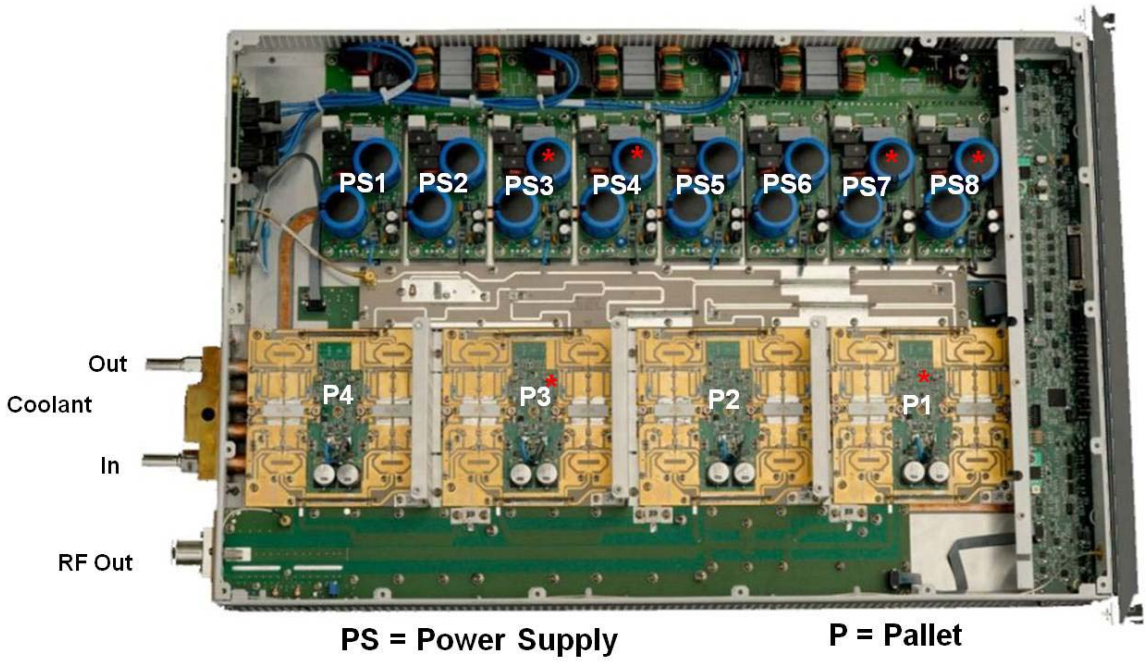

Figure 5-4 PA/IPA Module Pallet and Power Supply Numbering

Figure 5-4 gives the power supply and pallet identification numbers for PA and unmodified IPA modules. Components that are removed from modified IPA modules are denoted with asterisks. Modified IPA modules are used in transmitters with eight or less PA modules.

The test connector on the front of the PA or IPA module can be used to determine which pallet or power supply has failed. An optional hand held meter can be attached to the connector to display the status and fault information outlined in Table 5-2. If the optional meter is not available a multimeter can be used to measure voltages on the connector pins. The normal measured voltages are given in the following table in parenthesis. These voltage values assume that the module is enabled but no RF input is applied.

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Table 5-2 PA Module Test Connector Pin Out and Typical Voltages

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
1	/ON-OFF STATUS (0V -4.9V)	2	PS8 VOLTAGE (3.8V)	27	P3 FET 1 CURRENT (.3V)	28	GND
3	PS VOLT SELECT (44=5.15V, 46=4.12V, 48=2.49V, 50= .87V)	4	GND	29	P3 FET 2 CURRENT (.3V)	30	CANH (3.2V)
5	AVG INPUT POWER (.012V)	6	+12V (11.9V)	31	P4 FET 1 CURRENT (.3V)	32	CANL (0V)
7	GND	8	+12V (11.9V)	33	P4 FET 2 CURRENT (.3V)	34	GND
9	OUTPUT POWER (.023V)	10	PALLET 1 TEMP (2.0V)	35	PA SUM CURRENT (.3V)	36	/SPI-CS(TMS) (3.2V)
11	REFLECTED POWER (.022V)	12	PALLET 2 TEMP (2.0V)	37	PS1 VOLTAGE (3.8V)	38	SP1-SCK(TCK) (3.2V)
13	FAULT STATUS 3 (4.95V)	14	PALLET 3 TEMP (2.0V)	39	PS2 VOLTAGE (3.8V)	40	SPI-MOSI(TDI) (3.2V)
15	FAULT STATUS 2 (4.95 V)	16	PALLET 4 TEMP (2.0V)	41	PS3 VOLTAGE (3.8V)	42	SPI-MISO (TDI) (3.2V)
17	FAULT STATUS 1 (0V)	18	AMBIENT TEMP (2.0V)	43	PS4 VOLTAGE (3.8V)	44	SPI-JTAG-SEL (3.2V)
19	P1 FET 1 CURRENT (.3V)	20	ON/OFF FROM TB (0 V)	45	PS5 VOLTAGE (3.8V)	46	GND
21	P1 FET 2 CURRENT (.3V)	22	PSV TB SEL (0 V)	47	PS6 VOLTAGE (3.8V)	48	BP SYNC PRESENT (4.9V)
23	P2 FET 1 CURRENT (.3V)	24	GND	49	PS7 VOLTAGE (3.8V)	50	GND
25	P2 FET 2 CURRENT (.3V)	26	GND				

5.6 PA and IPA (driver) Pallet Replacement

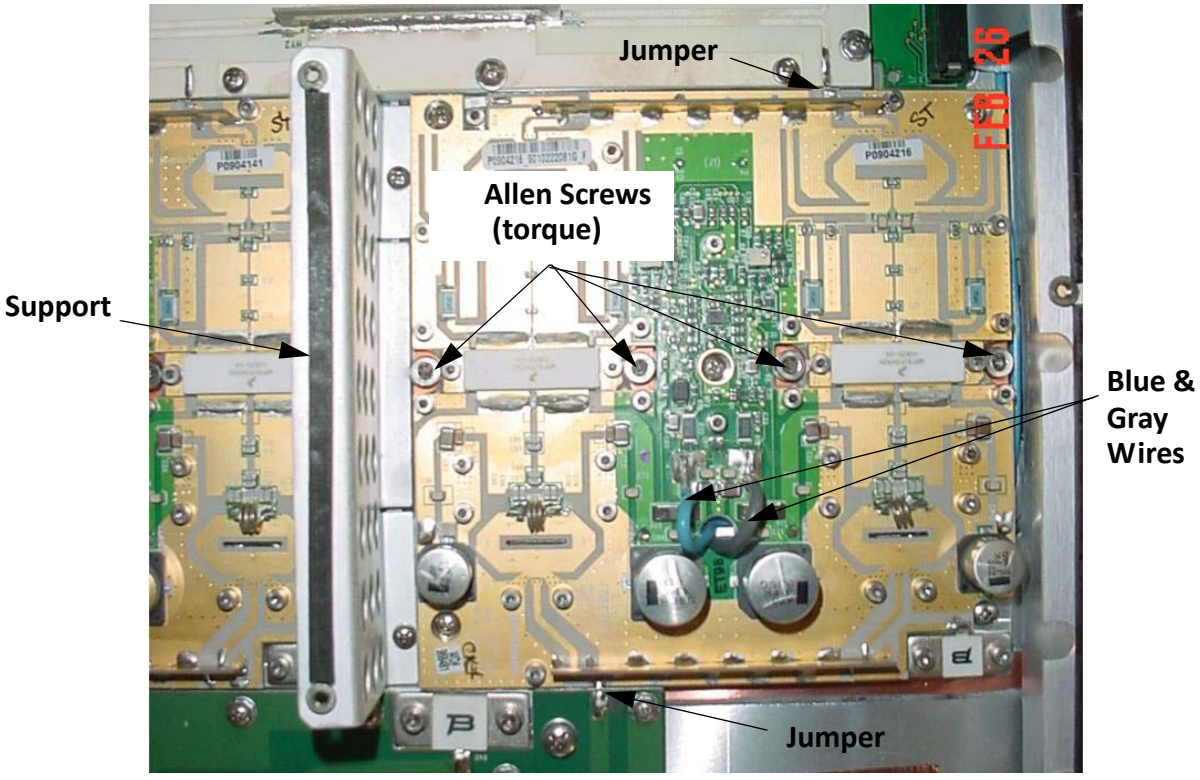

Figure 5-5 PA Module Pallet (one of four per module)

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STEP 1 **Turn off PA module breaker.**

Warning

MODULE MAY BE HOT. ALLOW THE MODULE TO COOL BEFORE REMOVAL.

STEP 2 **Wait 30 seconds for the module to cool.**

STEP 3 **Unscrew retaining screws and remove PA module.**

STEP 4 **Remove PA module cover.**

STEP 5 **Remove four (4) center pallet hold down screws (Allen head).**

STEP 6 **Remove five (5) additional pallet hold down screws (Phillips head).**

STEP 7 **De-solder two jumpers and the blue & gray DC supply wires.**

STEP 8 **Remove board and cleanup heat transfer compound.**

Note

Removal of the pallet may be difficult due to the presence of the heat transfer compound under the board. To remove the board first remove the cover supports either side of the board. Removal of the supports allows room to insert a flat blade screwdriver beneath the edge of the board. Use the screwdriver to gently pry upward without placing stress on adjacent boards. Repeat this process along the edges of the board in several places until it loosens up.

STEP 9 **Reapply heat transfer compound. Use a small roller or brush to apply even, thin coat.**

STEP 10 **Install pallet and all hold down screws.**

STEP 11 **Torque four (4) allen screws to 30 in lbs.**

STEP 12 **Solder two jumpers and the blue & gray DC supply wires.** Material to replace the jumpers is included in the pallet replacement kit. Cut the replacement jumpers to match those removed.

STEP 13 **Replace PA module cover.**

STEP 14 **Replace PA module in rack. Tighten module hold down screws.**

STEP 15 **Turn on PA module breaker.** Press the transmitter ON button to reactivate all modules that are OFF.

5.7 PA Module AC/DC Converter (PS) Board

5.7.1 PS Board Removal and Replacement

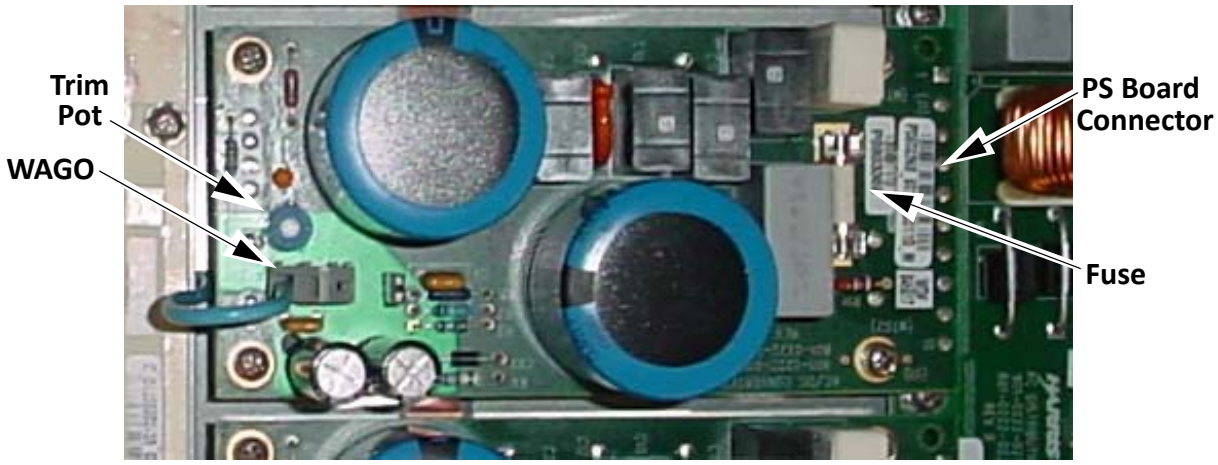

Figure 5-6 PA Module AC/DC Converter (PS power supply) Board

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Note

PS board fuse is 8A 250V fast blow.

STEP 1 **Turn off PA module breaker.**

Warning

MODULE MAY BE HOT. ALLOW THE MODULE TO COOL BEFORE REMOVAL.

STEP 2 **Allow the module to cool for 30 seconds.**
STEP 3 **Unscrew retaining screws and remove PA module.**
STEP 4 **Remove PA module cover.**
STEP 5 **Remove four (4) PS hold down screws (Phillips screws).**
STEP 6 **Remove supply wire from WAGO block.**
STEP 7 **Remove board from connector and cleanup heat transfer compound.**
STEP 8 **Install a new heat transfer pad (411-0126-000).**
STEP 9 **Install new PS.**
STEP 10 **Install PS hold down screws.**
STEP 11 **Reconnect supply wire to WAGO.**
STEP 12 **Replace PA module cover.**
STEP 13 **Replace PA module in rack. Tighten module hold down screws.**
STEP 14 **Turn on PA module breaker.**
STEP 15 **Press transmitter On button to activate all modules that are turned off.**
STEP 16 **End of procedure.**

5.7.2 AC/DC Converter (PS) Board Output Voltage

The output of the PS board (also referred to as the AC/ DC converter board) changes depending on transmitter modulation type. To operate properly the output of the PS board must be initially adjusted to 48V. This adjustment is made in the factory on each board prior to installation into a module or shipment as a replacement part. The output voltage can also be set in the field if a module test system is available. The optional PA module test system part number is 971-0040-080.

5.7.2.1 Setting AC/DC Converter Voltage

STEP 1 **Follow the PS board replacement steps outlined in Section 5.7.1 on page 5-9 stopping at step 10.**
STEP 2 **Place the module in the module test fixture.**
STEP 3 **Remove JP1**
STEP 4 **Activate the module and set Vout to 48 V using the trim pot shown in Figure 5-6 on page 5-9.**
STEP 5 **Replace JP1.**
STEP 6 **Complete steps 10 -13 in Section 5.7.1 on page 5-9.**
STEP 7 **End of procedure.**

The TCU sends a Vtrim voltage to the PS boards. The Vtrim voltage varies depending on the transmitter modulation selection. The PS output varies depending on the Vtrim signal received from the TCU. The Vtrim levels are given below.

Vtrim Levels:

- 5.755V ---- 44V
- 4.122 V --- 46V
- 2.490V ---- 48V
- 0.875V ---- 50V

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5.8 ALC Voltage Adjustment

The cabinet ALC voltage is displayed on the Output screen as shown in Figure 5-7. At full TPO (and thoroughly warmed up) the ALC voltage should be in the 3.2 to 3.6 V range (closer to 3.6 V is more desirable). ALC voltage is used to adjust the electronic attenuator in the PDU to raise or lower power. As the PA modules heat up their gain decreases and while in Auto mode the ALC voltage will increase automatically to keep power output stable. ALC voltage has a maximum value of 4 V. Once the 4V level is reached further increases in power output are not possible.

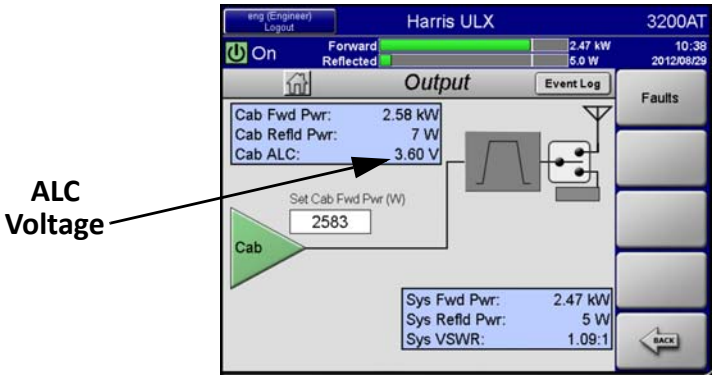

Figure 5-7 Output Screen

5.8.1 ALC Voltage Adjustment Procedure

Note

The following procedure assumes that the transmitter cabinet has been previously calibrated and operating normally. The cabinet power calibrations are performed during final test at the Harris factory.

STEP 1 **Transmitter should be connected to a known good test load or antenna system capable of handling the full transmitter power.**

STEP 2 **Adjust transmitter output to desired operational TPO with power control set to Auto.**

STEP 3 **Allow transmitter to warm up for 30 minutes.**

STEP 4 **Navigate to the Output screen and check ALC voltage level.**

STEP 5 **If ALC voltage level is below 3.2 V or above 3.6V proceed with the following steps.**

STEP 6 **Turn transmitter Off.**

STEP 7 **Lower ALC voltage by decreasing attenuator AT8. Raise ALC voltage by increasing AT8.** AT8 is located at the input to the PDU splitter which is located just behind the PDU modules. It can be accessed by opening the rear door and looking behind the PDU modules.

STEP 8 **Change AT8 up or down in 1 dB increments.**

Caution

AVOID MAKING LARGE CHANGES TO AT8 WHICH MAY CAUSE DAMAGING POWER OVERSHOOTS. MAKE THE CHANGES INCREMENTALLY IN 1 DB STEPS.

STEP 9 **Turn transmitter On and allow power to achieve nominal level.**

STEP 10 **Repeat steps 6 to 10 until ALC falls into the 3.2 - 3.6V range.**

STEP 11 **Switch to the other PDU and check ALC level. It will likely produce a slightly higher or lower ALC value. As long as it falls within the 3.2-3.6V range that is acceptable. If it is slightly above the 3.6V range that is acceptable as well, as long as the transmitter has enough headroom to reach full operating power under hot conditions.**

STEP 12 **End of Procedure.**

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5.9 Analog Power Calibrations

Other than system forward & reflected calibrations during installation, power calibration should be required only if the down converter board, the RF detector board (in TCU), or if a directional coupler or signal cable is replaced. However, calibration is simple and can be done whenever it is deemed necessary. The only required power calibrations are:

a. System Forward Power (after filters)
b. System Forward Sound (aural) Power
c. PA Cabinet Forward Power (before filters)
d. PA Cabinet Forward Sound (aural) Power
e. System Reflected Power (after filters)
f. PA Cabinet Reflected Power (before filters)
g. Exciter Forward Power
h. PDU Forward Power

Note

Forward and reflected power calibrations should only be done while operating the transmitter into a known good load or a low VSWR antenna system.

5.9.1 Average and Peak Power Conversion

With a blanking level (black picture with no setup) signal applied to the transmitter video input terminals and sync level set to 300 mV (PAL) or 40 IRE (NTSC), the required average carrier power can be calculated by multiplying the required peak power of the transmitter by one of the factors below, depending on system type.

The chart below lists the supported systems, the conversion factor for vision only calibration, and conversion factors for calculating average power when aural carrier is present in the signal.

Also listed are the formulas to calculate factors for other aural injection levels, as well as the formula for calculating the factor when there is more than 1 aural carrier, such as Nicam or Dual Carrier sound systems.

Table 5-3 Average to Peak Conversion Factors

Analog System	Visual Only	Visual plus (MONO) Aural Injection at Indicated Levels							
		-8 dB	-9 dB	-10 dB	-11 dB	-12 dB	-13 dB	-14 dB	-15 dB
B	0.567	0.726	0.693	0.667	0.647	0.630	0.617	0.607	0.599
G	0.567	0.726	0.693	0.667	0.647	0.630	0.617	0.607	0.599
H	0.595	0.753	0.721	0.695	0.674	0.658	0.645	0.634	0.626
I	0.609	0.767	0.735	0.709	0.688	0.672	0.659	0.648	0.640
D	0.595	0.753	0.721	0.695	0.674	0.658	0.645	0.634	0.626
K	0.595	0.753	0.721	0.695	0.674	0.658	0.645	0.634	0.626
K1	0.595	0.753	0.721	0.695	0.674	0.658	0.645	0.634	0.626
M	0.595	0.753	0.721	0.695	0.674	0.658	0.645	0.635	0.626
N	0.597	0.755	0.723	0.697	0.676	0.660	0.647	0.636	0.628

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5.9.1.1 Average and Peak Conversion Formula and Examples

Average Power = Peak Visual Power * Factor

Peak Visual Power = Average Power / Factor

Example 1: Calculate the average power of a System M transmitter operating at 1000W peak visual with an aural injection level of -10dB.

Factor for System M with -10dB aural injection = 0.695

Average Power = 1000W * 0.695 = 695W

*Example 2:*Calculate the peak visual power of a System K transmitter with -13dB aural injection if the average power is 1600W.

Factor for System K with -13dB aural injection = 0.645

Peak Visual Power = 1600W / 0.645 = 2480W

Example 3: Calculate the average power of a System B transmitter operating at 60kW peak visual with no aural.

Factor of System B, visual only = 0.567

Average Power = 60kW * 0.567 = 34.02kW

Use the following formula to calculate factors for other aural injection levels:

$$\text{Factor} = v + 10^{(a/10)}$$

Where: v = visual only factor for system

a = aural injection level

*In cases with multiple aural carriers, (Nicam, Dual Carrier) add the factors for each aural carrier to the visual factor.

Example 4: Aural carriers at -13dB and -20dB for system B

Factor = v + 10(a/10) +10(a/10)

Factor = v + 10(-13/10) + 10(-20/10)

Factor = 0.567 + 0.0501 + 0.01

Factor = 0.627

5.9.2 Forward Power Calibration

Equipment Used:

- Maxiva precision directional couplers (precision meaning that the coupling ratio has been measured at the operating frequency)
- Averaging power meter with power probe

Note

Power calibrations must be performed using the local GUI screen. In order to change calibration settings the user must supply a login and a password. When the transmitter ships from the factory the local GUI default login is "admin" and the default password is "admin" (do not include quotation marks in login or password). The default password allows setting of remote passwords only. Refer to "3.2.2 TCU - Initial Login & Passwords" on page 3-2. You will not be able to make changes or have remote access without changing the default username/password.

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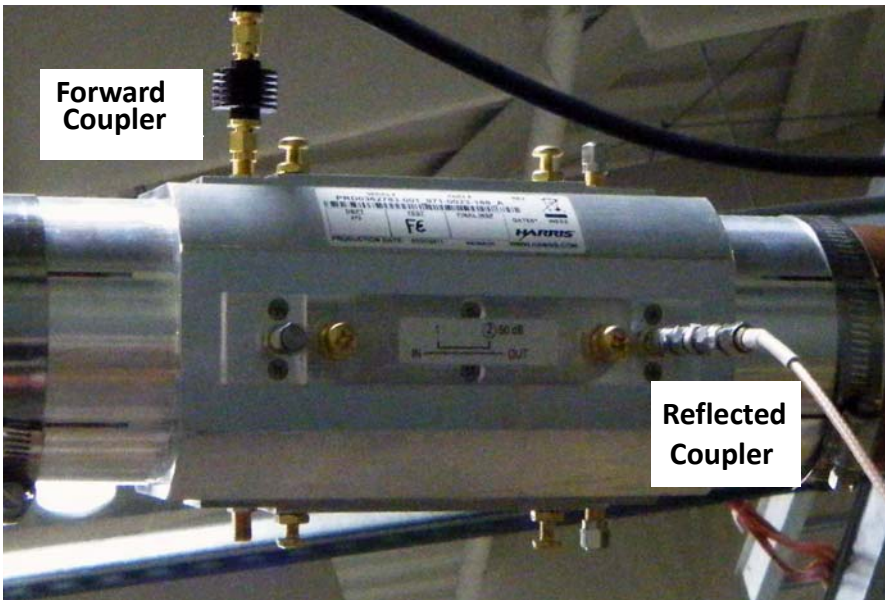

Figure 5-8 Typical Output Power Coupler

5.9.2.1 Calibrate System Forward Visual Power

STEP 1 **Calibrate the power meter following manufacturers instructions.**

STEP 2 **Set the meter offset to the value printed on the coupler, or as supplied with a data sheet included with the factory test data.**

STEP 3 **Remove the sample cable from the system forward directional coupler (after filter) to be calibrated (see Figure 5-8).**

STEP 4 **Connect the power meter probe to the system forward directional coupler port. Coupler designs like the one shown in Figure 5-8 must have 50 ohm terminations on the port opposite the measurement port. The power meter probe must be supported to prevent damage to connectors.**

STEP 5 **Disable the sound (aural) carrier via the Apex M2X control screens.**

Note

The M2X exciter must be controlled via a web browser. See the M2X manual for detailed instructions.

STEP 6 **Select 0% APL (Black Level, no setup for NTSC cases) at video generator. Connect to video input.**

STEP 7 **Press and hold the power LOWER button for 40 seconds or navigate to Output screen and set Cab. Ref. Pwr. to zero. Either of these steps will insure that the transmitter does not produce large amounts of RF power at turn on.**

STEP 8 **Verify the power output with the power meter attached to the forward port of the system output directional coupler. Turn on and while monitoring cabinet reflected power, slowly adjust the Maxiva analog transmitter output up to licensed nominal power (as programmed in the System Setup screen). If high levels of cabinet reflected power are noted, stop raising power, a bad load, transmission line connection, or antenna is indicated.**

Note

At Black level, the peak vision carrier power can be calculated by dividing the measured average power displayed on the power meter by one of the factors found in Section 5.9.1 on page 5-12. Note that the Sys Vision Power (kWpk) entered on the System Setup screen is peak power derived from this division.

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STEP 9 **Allow the transmitter to run for several minutes to give the amplifiers time to warm up and stabilize.**

STEP 10 **Verify that the sync ratio is correct for the desired operating system. The sync level is set in the M2X exciter. Typical sync level for PAL is 300 mV and 40 IRE units for NTSC. Readjust output power if sync. level is readjusted.**

STEP 11 **Press the manual button on the TCU and hold it in for 5 seconds.**

STEP 12 **Verify that the output power is stable and at the desired peak visual output power level (divide this average power reading, from the power meter, by one of the factors inSection 5.9.1 on page 5-12 , to obtain *peak* value of the vision carrier).**

STEP 13 **Disconnect the power meter probe from the forward coupler port, then reconnect forward sample cable to coupler.**

Note

The detector voltage values are provided on the Sys Pwr Calibrate screen shown in Figure 5-9. They are in the column to the right labelled Detector. The Sys Vis (kW) detector voltage level should be between 3.0 and 3.2V at full rated power. Operating in this range insures measurement accuracy (detector's linear region). If the detected levels are too high, attenuation must be added at the coupler port to reduce the detected voltage level.

STEP 14 **Access the Sys Pwr Calibrate screen press System>System Service>System Setup>System Power Calibrate shown in Figure 5-9.**

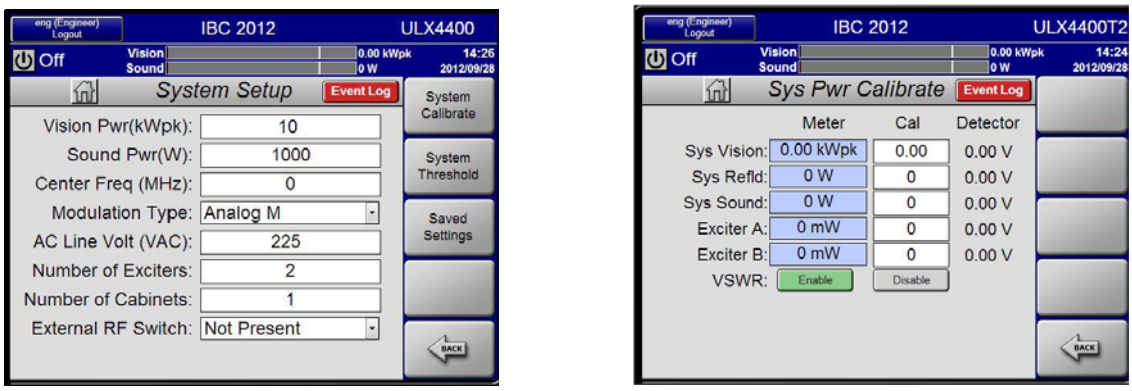

Figure 5-9 System Setup and System Power Meter Calibration Screens (Analog)

STEP 15 **Click on the corresponding window for Sys Vis power, opening a numeric entry box.**

STEP 16 **Enter the value (in peak kW) determined in step STEP 12 on page 5-15 above.**

STEP 17 **Click on DONE to store the changes, or CANCEL to ignore all changes made.**

STEP 18 **Press the Auto Power Control button to enable ALC.**

STEP 19 **Enable the sound (aural) carrier via the Apex M2X control screens.**

STEP 20 **Restore normal video program input signal.**

STEP 21 **End of procedure.**

5.9.2.2 Calibrate Cabinet Forward Visual Power

STEP 1 **Before performing cabinet calibration confirm that the cabinet ALC voltage is within the range described in Section 5.8.1 on page 5-11.**

STEP 2 **Repeat the previous procedure using the internal cabinet forward (incident) coupler sample, shown in Figure 5-11 on page 5-16, entering the data in the corresponding PA cabinet calibrate window shown in Figure 5-10. This screen is accessed by pressing System>System Service>Cabinet Setup>Cabinet Power Calibrate.**

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Note

Be sure to enter the incident (forward) coupler's offset into the power meter. Different couplers will have different coupling values. The coupling values also change with frequency.

STEP 3 **End of procedure.**

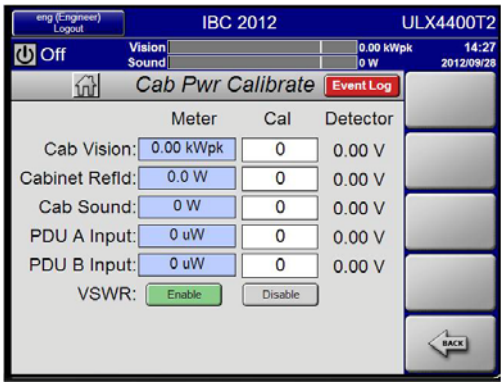

Figure 5-10 Cabinet Power Calibrate Screen (Analog)

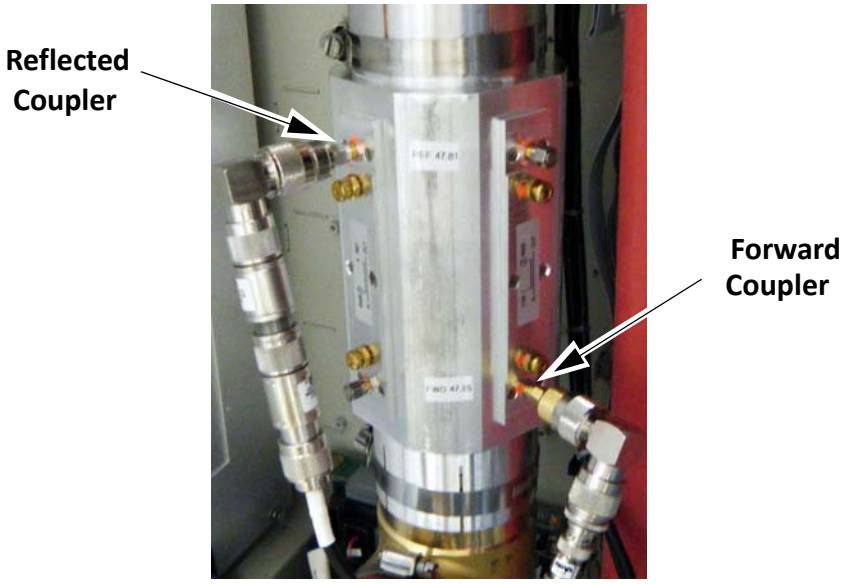

Figure 5-11 Cabinet Coupler

5.9.2.3 Calibrate System Forward Sound (aural) Power

This procedure **must** be performed after calibration of forward visual power as described in 5.9.2.1 on page 5-14:

STEP 1 **Enable sound carrier via the Apex M2X control screens.**

Note

If the transmitter is on, the visual carrier power will decrease slightly when the sound (aural) carrier is turned on.

STEP 2 **Select 0% APL (Black Level) at video generator. Connect generator output to transmitter video input.**

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STEP 3 **Turn on and adjust transmitter to 100% rated *visual* peak power as indicated on the GUI bar graph.**

STEP 4 **Remove the sample cable from the system forward directional coupler to be calibrated (see Figure 5-13).**

STEP 5 **Calibrate the power meter and set the power meter offset to the value printed on the coupler, or as supplied with the factory test data and connect the averaging power meter probe to the system coupler forward (incident) port.**

STEP 6 **Note the average power meter reading, and subtract the system visual *average* power noted in STEP 12 of the procedure 5.9.2.1 from the average power measured here. The result is the forward system power - sound carrier level.**

STEP 7 **Disconnect the power meter probe, and reconnect forward sample cable to the coupler.**

STEP 8 **Press System>System Service>System Setup>System Power Calibrate to view Figure 5-9 above.**

STEP 9 **Click on the corresponding window for Sys Aural, opening a numeric entry box.**

STEP 10 **Enter the value (in kW) determined in STEP 6 above.**

STEP 11 **Click on DONE to store the changes, or CANCEL to ignore all changes made.**

STEP 12 **Restore normal video program input signal.**

STEP 13 **End of procedure.**

5.9.2.4 Calibrate Cabinet Forward Sound (aural) Power

The Cab Pwr Calibrate screen is accessed by pressing System>System Service>Cabinet Setup>Cabinet Power Calibrate.

STEP 1 **Repeat the entire procedure described in 5.9.2.3 on page 5-16 using the cabinet forward (incident) sample (as shown in Figure 5-11 on page 5-16), entering the data in the corresponding Cab Aural (kW) window.**

Note

Be sure to enter the forward (incident) coupler's offset into the meter before making the measurement.

STEP 2 **End of procedure.**

5.9.3 Reflected Power Calibrate

This procedure establishes the values used to calculate the VSWR protection thresholds for foldback and fault events. These values are based on the "Visual Pwr Out" value entered into the System Setup screen.

- The foldback power level (based on system power) can be set by navigating to System>System Service>System Setup>System Threshold to display the Threshold Setting screen. The sys fldbck pwr level in W can be entered there. The maximum value allowed is 2.78% of the System Pwr Out (W) value on the System Setup screen. The 2.78% reflected power level is equivalent to a 1.4:1 VSWR.
- The system fault threshold level (based on system reflected power level) can be set by the user. Setting the fault threshold level is done by entering a trip voltage level in the Sys Reflected window on the Threshold Setting screen. The voltage entered here should correspond to 100mV less than the detected voltage level that indicated when calibrating the system reflected power as described in 5.9.3.1 Calibrate System Reflected Power.
- The cabinet fault threshold is set to a VSWR = 1.9:1 at the factory and is not adjustable by the user. A 1.9:1 VSWR corresponds to 9.63% reflected power.

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5.9.3.1 Calibrate System Reflected Power

Note

Before attempting reflected calibration forward (visual and aural) calibration must be confirmed.

STEP 1 **Turn on and adjust transmitter to 100% rated *visual* peak power as measured with an averaging power meter.**

STEP 2 **. Set video input signal to 50% flat field (gray) and turn sound carrier on.**

STEP 3 **Press System>System Service>System Setup>System Calibrate to view the GUI screen shown in Figure 5-9 on page 5-15.**

STEP 4 **Press disable VSWR.** This disables VSWR protection for 5 minutes. If reflected calibration is not finished within 5 minutes the transmitter will fault off and will need to be restarted before repeating the reflected calibration. Navigating away from the calibration screen will also reactivate VSWR protection.

STEP 5 **Remove the sample cable from the system reflected directional coupler (see Figure 5-8, above). If there are attenuators on the reflected coupler port keep them with the reflected sample cable.**

STEP 6 **Attach a 10 dB attenuator to the reflected sample cable (along with existing attenuators).**

STEP 7 **Remove the 50 ohm terminator from the opposite coupler port and place it on the reflected port.**

STEP 8 **Place the reflected cable (with 10 dB pad on the port where the terminator was removed. This essentially attaches the reflected cable (with 10 dB pad) to a forward sample.**

Note

The detector level (at licensed output power) should be between 2-3 V when the reflected cable is attached to a forward port with a 10 dB pad. If the reflected detector voltage is too high, additional pads must be added to get the voltage in the 2-3 V range. The added pads will stay with the reflected cable when it is moved back to the reflected port later in the procedure. The 10 dB pad will be removed when the reflected cable is placed back on the reflected port.

STEP 9 **Click on the corresponding window for Sys Refld power, opening a numeric entry box.**

STEP 10 **Enter the value that is 10% of licensed nominal output power.**

STEP 11 **Click on DONE to store the changes, or CANCEL to ignore all changes made. Record the reflected detector voltage for later use in setting the reflected power threshold.**

Note

Refer to "3.9.3.1.2 System Thresholds" on page 3-24 to get information on setting the system reflected threshold level. This level must be set before testing the VSWR protection (reflected power trip point). The reflected trip level should be set to the voltage level recorded in the previous step minus 100 mV.

STEP 12 **Verify the VSWR protection by pressing the Enable VSWR button on the CALIBRATE screen. The transmitter should fault off.**

STEP 13 **Remove the terminator from the reflected port and place it on the forward port.**

STEP 14 **Remove the 10 dB attenuator from the reflected cable.**

STEP 15 **Return the reflected cable to the reflected port.**

STEP 16 **Turn on the transmitter. It should come up to licensed nominal output power.**

STEP 17 **End of procedure.**

5.9.3.2 Calibrate Cabinet Reflected Power

Cabinet reflected power is normally calibrated at the factory during final test and it may not need to be calibrated in the field. The cabinet reflected trip point has been set at the factory and is not accessible via the GUI. Should recalibration of cabinet reflected power be required, and detector voltages are significantly changed for some reason, the cabinet reflected trip level can only be adjusted through use of a terminal emulator program like Teraterm. Contact Harris service if this is needed.

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STEP 1 **Repeat the above procedure *using the internal (cabinet) forward and reflected coupler samples* (see Figure 5-11 on page 5-16) to calibrate the reflected power at the cabinet output.**

Note

The detector level should be between 2-3V at rated visual forward power when the reflected cable is attached to the forward port with a 10 dB pad. If there are pads on the forward port to start with they should not be included with the added 10dB pad.

STEP 2 **Enter the 10% of measured forward cabinet power value in the window for Cab Refld (W).**

STEP 3 **End of procedure.**

5.9.4 Exciter Output Calibration

STEP 1 **Turn on the transmitter and adjust to nominal power.**

STEP 2 **Set the video generator to black picture, no setup.**

STEP 3 **With the exciters operating use the web browser to access each exciter and record the output levels for exciters A and B (if present). These exciter levels were calibrated at the factory.**

STEP 4 **The transmitter GUI Exciter output is calibrated on the Sys Pwr Calibrate screen. To access the Sys Pwr Calibrate screen press System>System Service>System Setup>System Calibrate. The screen is shown in Figure 5-9 on page 5-15.**

STEP 5 **To calibrate, press the window of the *active* exciter output to be calibrated and enter the values noted on the exciter web browser screens.**

STEP 6 **End of procedure.**

5.9.5 PDU Calibration

The predriver unit (PDU) has a forward power directional coupler for each preamp module to measure input power. This power reading is given on the System>System Service>Cabinet Setup>Cabinet Pwr Calibrate screen shown in Figure 5-1.

Calibration Procedure:

Note

This value is preset at the factory. Should it need to be reset in the field use this procedure.

STEP 1 **Turn on the transmitter and adjust to licensed power.**

STEP 2 **Set the video generator to black picture, no setup.**

STEP 3 **Remove the cable at the output of the PDU splitter and use an average power meter to measure the splitter power output.**

STEP 4 **Reconnect the cable.**

STEP 5 **Go to the Cab Pwr Calibrate screen (Figure 5-1) and check the PDU detector value for the active PDU which should be between 1 and 4 V (set at factory and varies with transmitter model). This voltage comes from detectors at the input of each PDU.**

Note

This voltage is used as a reference to indicate exciter power output. If too low the transmitter ALC will not adjust in Auto mode. If less than a factory set threshold it assumes there is an exciter issue and disables ALC.

STEP 6 **Divide the measured average power out of the splitter by the appropriate factor fromSection 5.9.1 on page 5-12.**

STEP 7 **Press the window of the active PDU input to be calibrated and enter the value determined in STEP 6.The value entered should be in uW (microwatts).**

STEP 8 **Press DONE to store the changes or CANCEL to discard the changes.**

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STEP 9 **Select the other predriver and repeat the procedure to calibrate the other predriver power output.**

STEP 10 **End of procedure.**

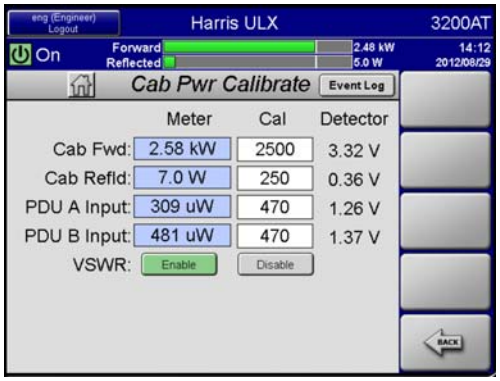

Figure 5-1 Cab Pwr Calibrate Screen

5.9.6 System Threshold Settings

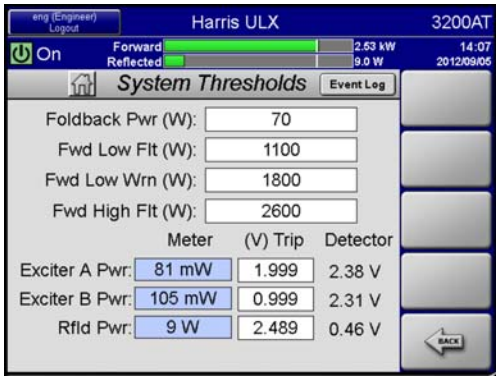

Figure 5-12 System Threshold Setting Screen

Table 5-4 System>System Service>System Setup>System Threshold

Field	Explanation
Foldback Pwr	Sets pwr level (Watts) where power foldback begins. Maximum value is 2.8% of nominal output power, for a VSWR of 1.4:1. For a 6kW digital transmitter this corresponds to a reflected power level of 168W.
Fwd Low Flt	Sets power level where power bar turns red and a fault is entered into the log.
Fwd Low Warn	Sets kW level where power bar turns yellow.
Fwd High Flt	Sets kW level where power bar turns red and fault is entered into log.
Exciter A, B Pwr	Sets voltage threshold where exciter switch will occur. See Section 5.9.6.1 on page 5-21 for instructions.
Rfld Pwr	This value must be set by the customer. System reflected threshold voltage (sets the reflected power trip level) should be set to approximately 100 mV less than the detector voltage level noted in "5.9.3.1 Calibrate System Reflected Power" on page 5-18. For a 6kW digital transmitter this corresponds to a reflected power level of 578W, for a VSWR trip point of 1.9:1.

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5.9.6.1 Exciter A & B Threshold Settings

Exciter A and B detector levels should be approximately 2.7V. This assumes a 200mW (analog) out (black picture no setup on NTSC). These detector values will vary dramatically with normal picture transmission.

Exciter A and B threshold levels can be set using the following steps:

STEP 1 **Set the exciter to nominal output 200 mW peak visual, black picture.**

STEP 2 **Lower exciter output power to 100 mW (using the web browser GUI screens).**

STEP 3 **Switch video generator to white picture.**

STEP 4 **Press the threshold Cal window and adjust the Cal value higher in .1 V increments until the red fault LED on the TCU exciter switcher card lights.**

Note

To view the LED on the exciter switcher card the front panel of the TCU must be pivoted downward.

STEP 5 **Lower the threshold Cal window value in .05 V increments until the red LED on the exciter switcher card goes out.**

STEP 6 **Press done to accept this level.**

STEP 7 **Restore transmitter to normal operating condition and reset the exciter output power to 200 mW (or to the value it was previously at).**

STEP 8 **End of procedure.**

5.10 Digital Power Calibrations

Other than system forward & reflected calibrations during installation, power calibration should be required only if the RF detector board (in TCU), or a directional coupler or signal cable is replaced. However, calibration is simple and can be done whenever it is deemed necessary. The only required power calibrations are:

a. System Forward Power (after filters)
b. Cabinet Forward Power (before filters)
c. System Reflected Power (after filters)
d. PA Cabinet Reflected Power (before filters)
e. Exciter Forward Power
f. PDU Forward Power

Note

Forward and Reflected power calibrations should only be done while operating the transmitter into a known good load or a low VSWR antenna system.

5.10.1 Forward Power Calibration

Equipment Used:

- Maxiva Series precision directional couplers (precision meaning that the coupling ratio has been measured at the exact operating frequency)
- Averaging power meter with power probe

Note

Power calibrations must be performed using the local GUI screen. In order to change calibration settings the user must supply a login and a password. When the transmitter ships from the factory the local GUI default login is "admin" and the default password is "admin" (do not include quotation marks in login or password). The default password allows setting of remote passwords only. Refer to "3.2.2 TCU - Initial Login & Passwords" on page 3-2. You will not be able to make changes or have remote access without changing the default username/password.

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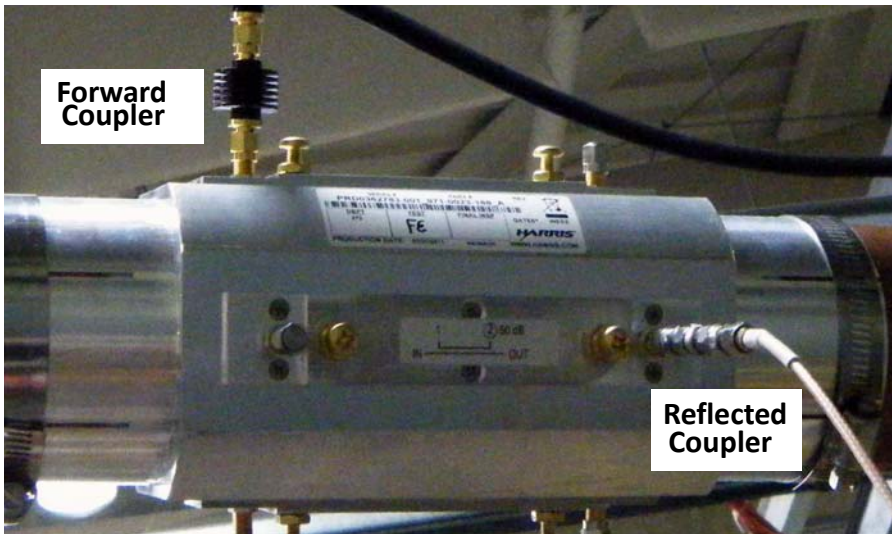

Figure 5-13 System Coupler

5.10.1.1 Calibrate Forward Total Power

STEP 1 **Calibrate the averaging power meter following manufacturers instructions.**

STEP 2 **Set the meter offset to the value printed on the coupler, or as supplied with a data sheet included with the factory test data.**

STEP 3 **Remove the sample cable from the system forward directional coupler (after filter) to be calibrated (see Figure 5-13).**

STEP 4 **Connect the power meter probe to the system forward directional coupler port. Coupler designs like the one shown in Figure 5-13 must have 50 ohm terminations on the port opposite the measurement port. The power meter probe must be supported to prevent damage to connectors.**

STEP 5 **Press and hold the power LOWER button for 40 seconds or navigate to Output screen and set Cab. Ref. Pwr. to zero. Either of these steps will insure that the transmitter does not produce large amounts of RF power at turn on.**

STEP 6 **Turn on transmitter and while monitoring cabinet reflected power, slowly adjust the Maxiva digital transmitter output up to licensed nominal power (as programmed in the System Setup screen). If high levels of cabinet reflected power are noted, stop raising power, a bad load, transmission line connection, or antenna is indicated.**

STEP 7 **Allow the transmitter to run for several minutes at nominal power to give the amplifiers time to warm up and stabilize.**

STEP 8 **Press the manual button on the TCU and hold it in for 5 seconds.**

STEP 9 **Re-adjust the transmitter power output as required to reach licensed nominal power. Be sure it is stable.**

STEP 10 **Disconnect the power meter probe from the forward coupler port then reconnect forward sample cable.**

Note

The detector voltage values are provided on the Sys Pwr Calibrate screen shown in Figure 5-14. They are listed in the column to the right labelled Detector. The Sys Fwd (kW) detector voltage level should be between 3.0 and 3.2V at full rated power. Operating in this range insures accuracy (detector's linear region). If the detected levels are too high, attenuation must be added at the coupler port to reduce the detected voltage level.

STEP 11 **Access the Calibration screen by navigating to System>System Service>System Setup>System Power Calibrate as shown in Figure 5-14.**

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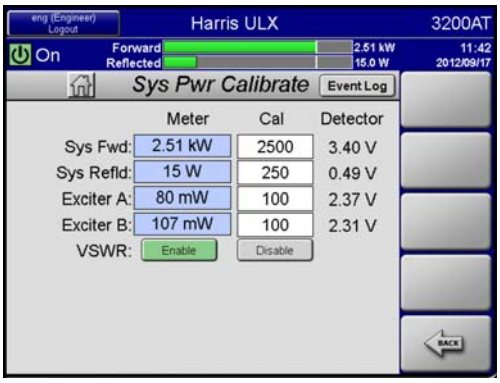

Figure 5-14 Sys Pwr Calibrate Screen

STEP 12 **Click on the corresponding Cal window for Sys Fwd power, opening a numeric entry box.**

STEP 13 **Enter the measured power out (in kW).**

STEP 14 **Press DONE to store the changes, or CANCEL to ignore all changes made.**

STEP 15 **Press the Auto power control button to enable ALC.**

STEP 16 **End of procedure.**

5.10.1.2 Calibrate Cabinet Forward Power

STEP 1 **Before performing cabinet calibration confirm that the cabinet ALC voltage is within the range described inSection 5.8.1 on page 5-11.**

STEP 2 **Repeat the previous procedure using the internal cabinet forward (incident) coupler sample (shown in Figure 5-15), entering the data in the corresponding Cabinet Setup>Cabinet Power Calibrate window shown in Figure 5-1 on page 5-26. The Cabinet Pwr Calibrate screen is accessed navigating to System>System Service>Cabinet Setup>Cab Pwr Calibrate.**

Note

Be sure to enter the forward (incident) coupler's offset into the power meter. Different couplers have different coupling values. The coupling values also change with frequency.

STEP 3 **End of procedure.**

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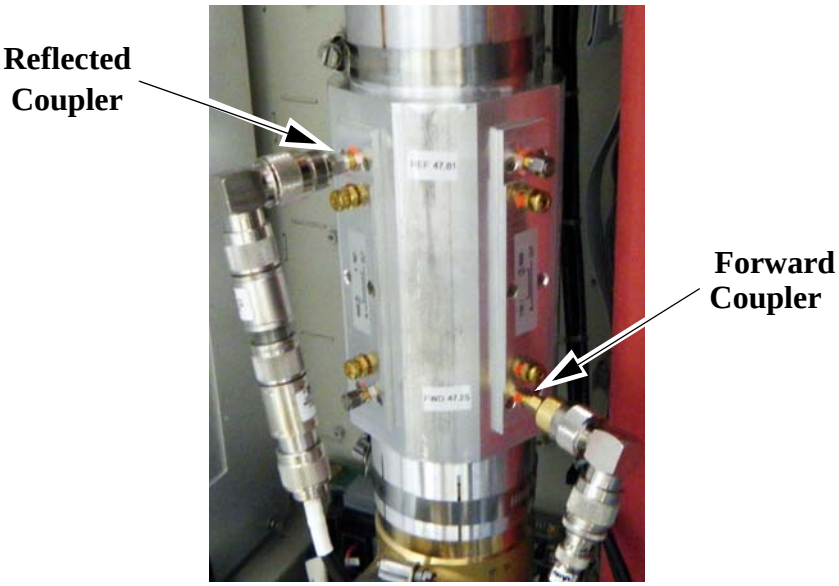

Figure 5-15 Cabinet Coupler

5.10.2 Reflected Power Calibration

This procedure establishes the values used to calculate the VSWR protection thresholds for foldback and fault events. These values are based on the "Fwd Pwr Out (W)" value entered into the System Setup screen in Figure 3-25 on page 3-22.

- The foldback power level (based on system power) can be set by navigating to System>System Service>System Setup>System Threshold to display the Threshold Setting screen. The Foldback Pwr level in W can be entered there. The maximum value allowed is 2.78% of the System Pwr Out (W) value on the System Setup screen. The 2.78% reflected power level is equivalent to a 1.4:1 VSWR.
- The system fault threshold level (based on system reflected power level) can be set by the user. Setting the fault threshold level is done by entering a trip voltage level in the Rfld Pwr window on the System Threshold screen. The voltage entered here should correspond to 100mV less than the detected voltage level indicated when calibrating system reflected power as described in Section 5.10.2.1, Calibrate System Reflected Power, on page 5-24
- The cabinet fault threshold is set to a VSWR = 1.9:1 at the factory and is not adjustable by the user. A 1.9:1 VSWR corresponds to 9.63% reflected power.

5.10.2.1 Calibrate System Reflected Power

Note

*Before attempting reflected calibration forward calibration **must** be confirmed.*

STEP 1 **Turn on and adjust transmitter output to licensed *average* power as measured with an averaging power meter.**

STEP 2 **Press System>System Service>System Setup>System Power Calibrate to view the System GUI screen shown in Figure 5-14 on page 5-23.**

STEP 3 **Press Disable VSWR. This disables VSWR protection for 5 minutes. If reflected calibration is not finished within 5 minutes the transmitter will fault off and will need to be restarted before repeating the reflected calibration. Navigating away from the calibration screen will also reactivate VSWR protection.**

STEP 4 **Remove the sample cable from the system reflected directional coupler. If there are attenuators on the reflected coupler port, keep them with the reflected sample cable.**

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STEP 5 **Attach a *a 10 dB pad* to reflected sample cable (along with existing attenuators).**

STEP 6 **Remove the 50 ohm terminator from the opposite coupler port and place it on the reflected port.**

STEP 7 **Place the reflected cable (with 10 dB pad) on the port where the terminator was removed. This essentially attaches the reflected cable (with 10 dB pad) to a forward sample port.**

Note

The detector level (at licensed output power) should be between 2 -3 V when the reflected cable is attached to a forward port with a 10 dB pad. If the reflected detector voltage is too high, additional pads must be added to get the voltage in the 2-3 V range. The added pads will stay with the reflected cable when it is moved back to the reflected port later in the procedure. The 10 dB pad will be removed when the reflected cable is placed back on the reflected port.

STEP 8 **Click on the corresponding Cal window for Sys Refld power, opening a numeric entry box.**

STEP 9 **Enter the value that is 10% of licensed output power (in Watts).**

STEP 10 **Click on DONE to store the changes, or CANCEL to ignore all changes made. Record the reflected detector voltage for later use in setting the reflected power threshold.**

Note

Refer to "3.9.3.1.2 System Thresholds" on page 3-24 to get information on setting the system reflected threshold level. This level must be set before testing the VSWR protection (reflected power trip point). The reflected trip level should be set to the voltage level recorded in the previous step minus 100 mV.

STEP 11 **Remove the reflected cable with 10 dB pad from the forward port.**

STEP 12 **Remove the terminator from the reflected port and place it on the forward port.**

STEP 13 **Remove the 10 dB attenuator from the reflected cable.**

STEP 14 **Return the reflected cable to the reflected port.**

STEP 15 **Press Enable VSWR.**

STEP 16 **End of procedure.**

5.10.2.2 Calibrate Reflected Cabinet Power

Cabinet reflected power is normally calibrated at the factory during final test and it may not need to be calibrated in the field. The cabinet reflected trip point has been set at the factory and is not accessible via the GUI. Should recalibration of cabinet reflected power be required, and detector voltages are significantly changed for some reason, the cabinet reflected trip level can only be adjusted through use of a terminal emulator program like Teraterm. Contact Harris service if this is needed.

STEP 1 **Repeat the above procedure *using the internal (cabinet) forward (incident) and reflected coupler samples* (see Figure 5-15 on page 5-24) to calibrate the reflected power at the cabinet output.**

Note

The detector level should be approximately 2-3 V when the reflected cable is attached to the forward port with a 10 dB pad. If there are pads on the forward port to start with they should not be included with the added 10dB pad.

STEP 2 **Enter the 10% of the measured forward cabinet power value in the window for Cab Refld (W).**

STEP 3 **End of procedure.**

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5.10.3 Exciter Output Calibration

STEP 1 **Turn on the transmitter and adjust to licensed power.**

STEP 2 **With the exciters operating, use the web browser to access each exciter GUI and record the output levels for exciters A and B (if present). These exciter levels were calibrated at the factory.**

STEP 3 **The transmitter GUI exciter output is calibrated on the Sys Pwer Calibrate screen. Access the Sys Pwr Calibrate screen navigating to System>System Service>System Setup>System Power Calibrate. The screen is shown in Figure 5-14 on page 5-23.**

STEP 4 **To calibrate, press the *active* exciter meter window and enter the output power level noted on the exciter web browser screens.**

STEP 5 **End of procedure.**

5.10.4 PDU Calibration

The predriver unit (PDU) has a forward power directional coupler for each preamp module to measure input power. This power reading is given on the System>System Service>Cabinet Setup>Cabinet Power Calibrate screen shown in Figure 5-1.

Note

This value is preset at the factory. Should it need to be reset in the field use this procedure.

STEP 1 **Turn on the transmitter and adjust to licensed power.**

STEP 2 **Remove the cable at the output of the PDU splitter (behind the PDU chassis) and use an average power meter to measure the splitter power output.**

STEP 3 **Reconnect the cable.**

STEP 4 **Go to the Cab Pwr Calibrate screen (Figure 5-1) and check the PDU detector value for the active PDU which should be between 1 and 3.2 V (set at factory and varies with transmitter model). This voltage comes from detectors at the input of each PDU. Enter the value measured in STEP 3 in the numeric entry box.**

Note

This voltage is used as a reference to indicate exciter power output. If too low the transmitter ALC will not adjust in Auto. If less than a factory set threshold it assumes there is an exciter issue and disables ALC.

STEP 5 **Press the window of the active PDU input to be calibrated and enter the values determined in STEP 5. The value entered should be in uW (micro Watts).**

STEP 6 **Press DONE to store the changes or CANCEL to discard the changes.**

STEP 7 **Select the other predriver and repeat the procedure to calibrate the other predriver power output.**

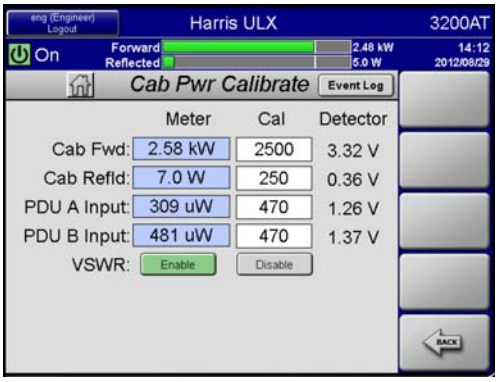

Figure 5-1 Cab Pwr Calibrate Screen

STEP 8 **End of procedure.**

5.10.5 System Threshold Settings

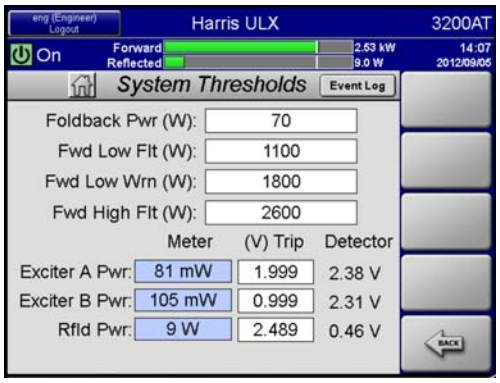

Figure 5-16 Threshold Setting Screen

Table 5-5 System>System Service>System Setup>System Threshold

Field	Explanation
Foldback Pwr	Sets pwr level (Watts) where power foldback begins. Maximum value is 2.8% of nominal output power, for a VSWR of 1.4:1. For a 6kW digital transmitter this corresponds to a reflected power level of 168W.
Fwd Low Flt	Sets power level where power bar turns red and a fault is entered into the log.
Fwd Low Warn	Sets power level where power bar turns yellow.
Fwd High Flt	Sets power level where power bar turns red and fault is entered into log.
Exciter A, B Pwr	Sets voltage threshold where exciter switch will occur. See Section 5.10.5.1 on page 5-27 for instructions.
Rfld Power	This value must be set by the customer. System reflected threshold voltage, to set the VSWR trip point, should be set to approximately 100 mV less than the detector voltage level noted in "5.10.2.1 Calibrate System Reflected Power" on page 5-24. Approximately 2.4V is typical. For a 6kW digital transmitter this corresponds to a reflected power level of 578W, for a VSWR trip point of 1.9:1.

5.10.5.1 Exciter A & B Threshold Settings

Exciter A and B detector levels should be approximately 2.7V. This assumes a 100mW (average) out.

Exciter A and B threshold levels can be set using the following steps:

STEP 1 **Set the exciter to nominal output power (approximately 100 mW average).**

STEP 2 **Lower exciter output power to 50 mW (use the web browser GUI screens).**

STEP 3 **Press the threshold Exciter Pwr Cal window and adjust the value upward in .1 V increments until the red fault LED on the TCU exciter switcher card lights.**

Note

To view the LED on the exciter switcher card the front panel of the TCU must be pivoted downward.

STEP 4 **Lower the threshold Cal window value in .05 V increments until the red LED on the exciter switcher card goes out.**

STEP 5 **Press done to accept this level.**

STEP 6 **Restore transmitter to normal operating condition and reset the exciter output power to nominal.**

STEP 7 **End of procedure.**

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5.11 PA Cabinet Fan Replacement

There are two 230V AC 50/60Hz fans in the Maxiva cabinet. They get their AC power from the control breakers on power distribution panel.

Note

Deactivating the control breakers will turn off the cabinet fans but they also will disable the TCU and exciters.

The cabinet fans operate continuously whenever the transmitter is on. The fans are redundant, either of the fans can be removed while the transmitter continues operating with one remaining operational fan. The cabinet cooling fans supply air to the PA modules, IPA (driver) modules and the predrivers. Exhaust air from the fans exits the cabinet at the top.

5.11.1 Cabinet Fan Removal

STEP 1 **Open the rear cabinet door.**

STEP 2 **Disconnect connectors J1 & J3 (see Figure 5-17) from the fan control board which lies just above the fan that is to be removed.**

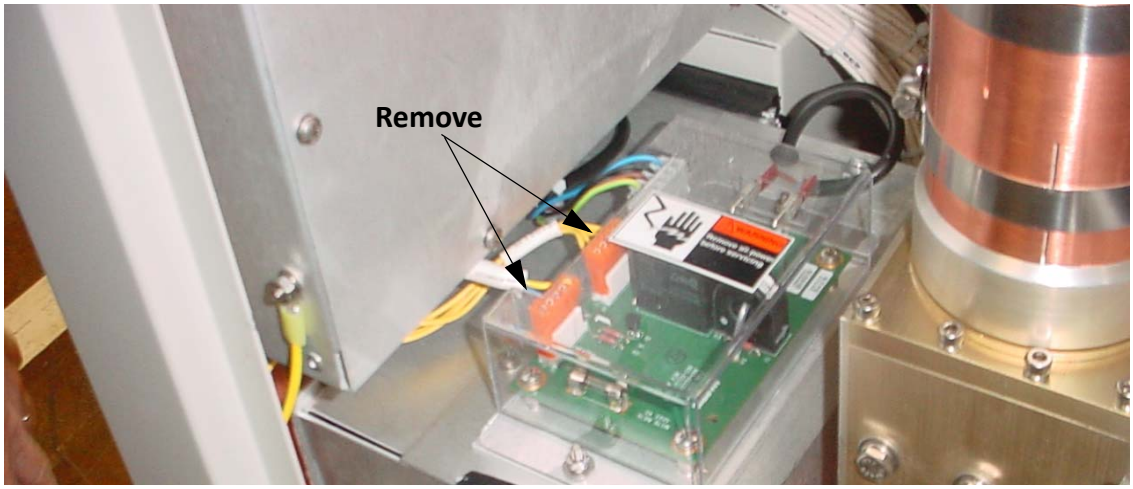

Figure 5-17 Fan Control Board Connectors J1 & J3

STEP 3 **Use a 10 mm socket driver to remove the two nuts (see Figure 5-18) that hold the fan assembly in place.**

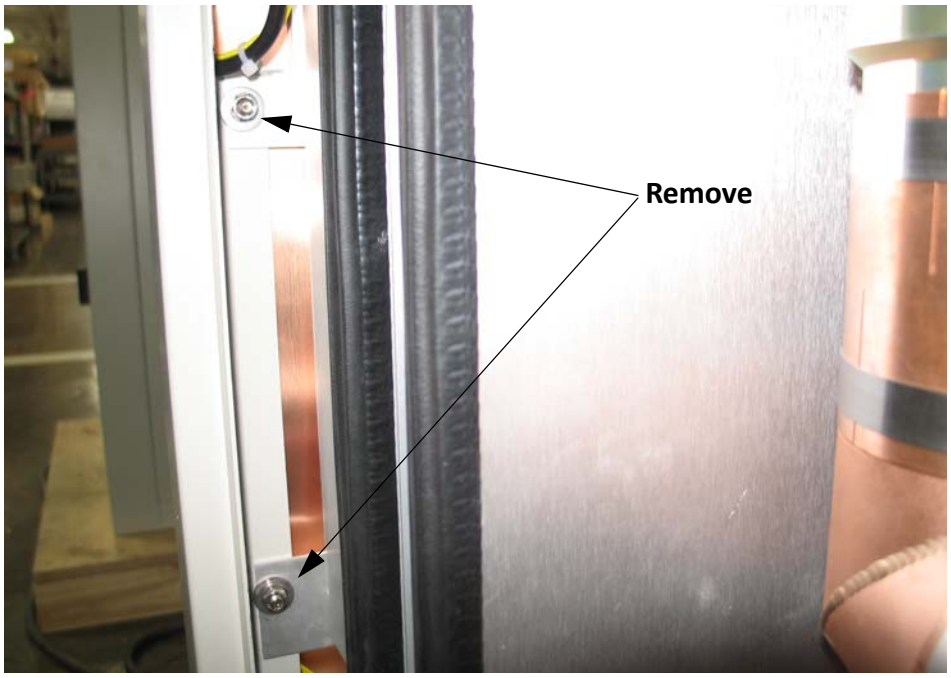

Figure 5-18 Fan Bracket Hardware

STEP 4 **Fan enclosure can now be removed from the cabinet angling the rear of the unit toward the center of the cabinet and pulling it out through the door opening.**

Note

The fan capacitor is located inside the fan enclosure.

Figure 5-19 Fan Capacitor (inside fan enclosure)

STEP 5 **Reverse the process to replace the fan.**

STEP 6 **End of procedure.**

5.12 PA Cabinet RF System Removal

Removal of the cabinet RF system is required if access to the PA backplanes, IPA backplanes, combiners or dividers is needed.

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5.12.1 RF System Removal

STEP 1 **Turn off the transmitter. Remove all power and turn off main breakers AC1 and AC2. Disable remote operation to prevent transmitter from being reactivated.**

STEP 2 **Remove the cabinet fan assemblies. The fan removal sequence is described in section 5.11 on page 5-28.**

STEP 3 **Loosen the clamp that holds the output coax in the flange (see Figure 5-20 on page 5-30).**

STEP 4 **Lift the output coax and inner conductor upward and away from the flange (see Figure 5-20 on page 5-30). Secure the coaxial line so it is out of the way.**

STEP 5 **Remove the four Phillips screws from the plate assembly at the top of the cabinet.**

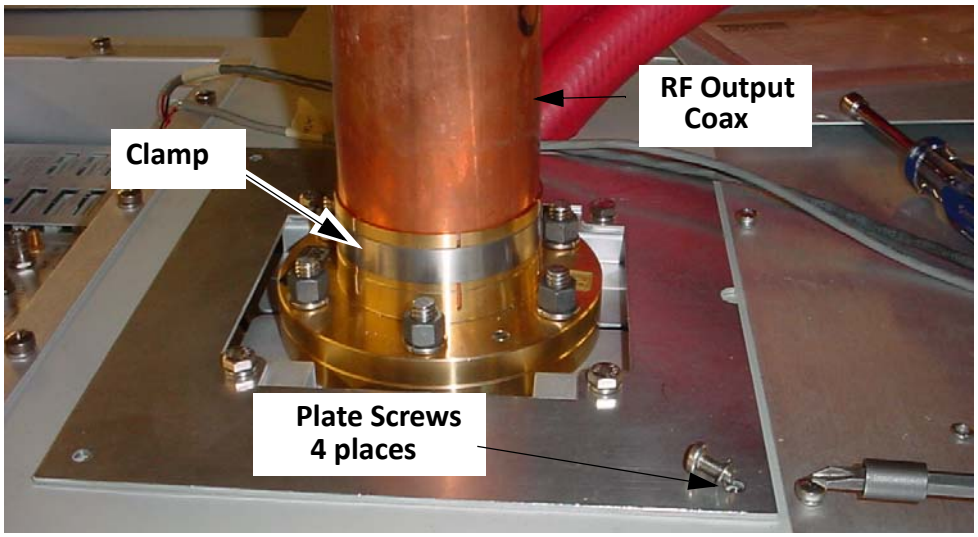

Figure 5-20 RF Output Plate

STEP 6 **Loosen the clamp on the outer conductor flange coupling that is located on the cabinet output directional coupler (see Figure 5-21 on page 5-30).**

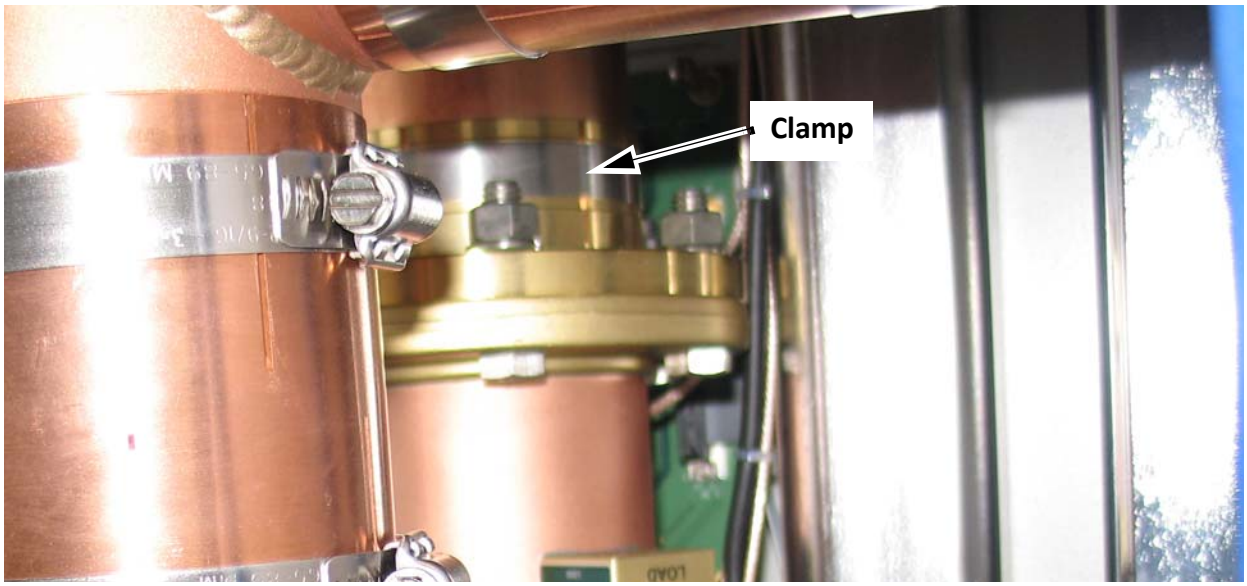

Figure 5-21 RF Output Coaxial Line Connection

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STEP 7 **Lift the output coax line (the line above the coupler) upward taking care to disconnect and support the inner conductor. Lift the inner and outer upward through the top of the cabinet. Store the coaxial line section in a safe location.**

STEP 8 **Loosen the clamp that holds the hybrid combiner reject port elbow in place while supporting the back to back elbow assembly and the reject load. Lower the elbow (see Figure 5-24 on page 5-32) to disconnect the inner conductor bullet. Lift the back to back elbows and reject load (with attached coolant hoses) up and out of the way. It can be temporarily tied up out of the way with a small rope or with heavy duty tie wraps.**

STEP 9 **Remove the bolt from the RF support bracket at the bottom of the cabinet (13 mm wrench). The bolt is shown in Figure 5-22 on page 5-31.**

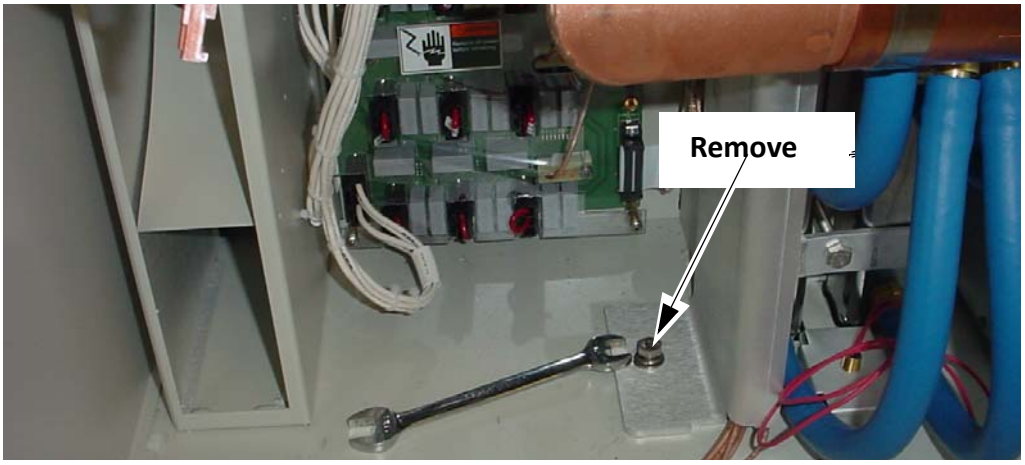

Figure 5-22 RF Support Bracket - Lower

STEP 10 **Use a 13 mm wrench to remove the two bolts from the center of the RF support bracket (see Figure 5-23 on page 5-31).**

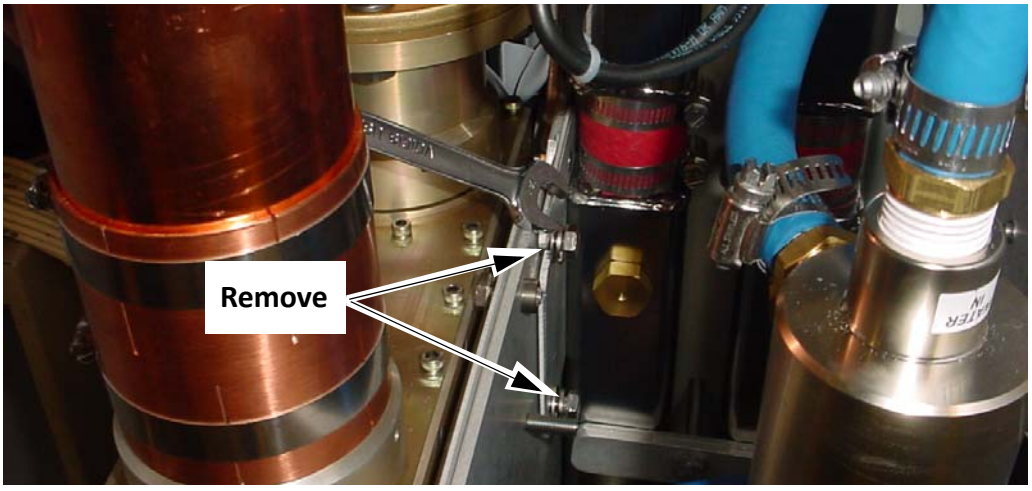

Figure 5-23 RF Support Bracket Lower

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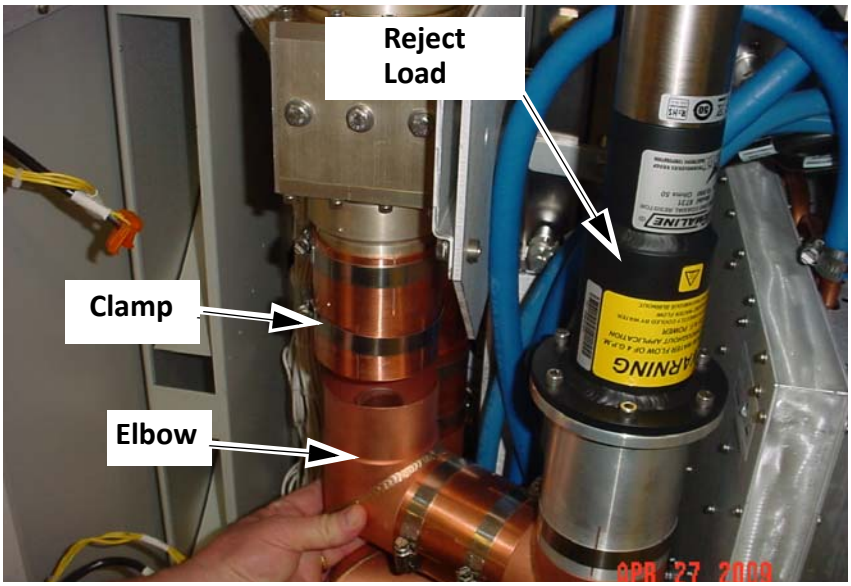

Figure 5-24 Reject Load Elbow.

STEP 11 **Remove the sample cables from the directional coupler at the output of the hybrid combiner.**

STEP 12 **While supporting the weight of the hybrid combiner/coax RF system loosen the clamps on outer conductor sleeves at the output of the lower and then the upper module combiners. Slide the coaxial sleeves to the right to expose the inner conductor. The loosened upper clamp is show in Figure 5-25 on page 5-32.**

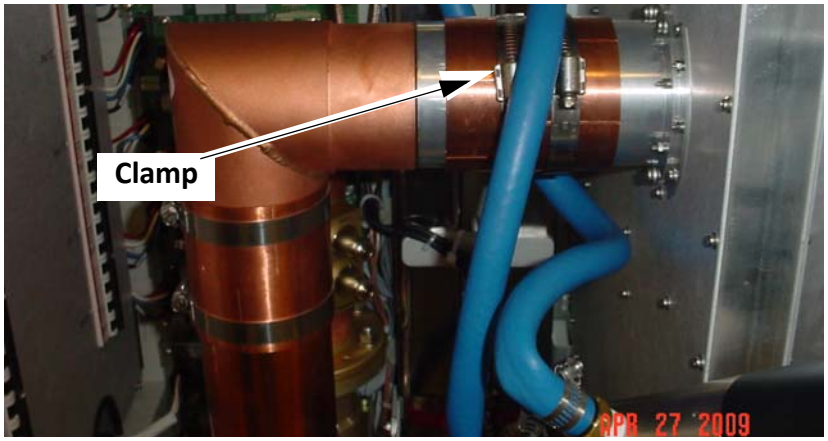

Figure 5-25 Upper Combiner Output Clamp

STEP 13 **Once the clamps on the combiner outputs are loose the hybrid coupler and coaxial assembly can be supported and then pulled away from the module combiners. The hybrid combiner/coaxial RF system can then be removed from the cabinet and stored in a safe location. The hybrid combiner/coaxial output assembly is shown in Figure 5-26 on page 5-33. The cabinet with the RF system removed is shown in Figure 5-27 on page 5-33.**

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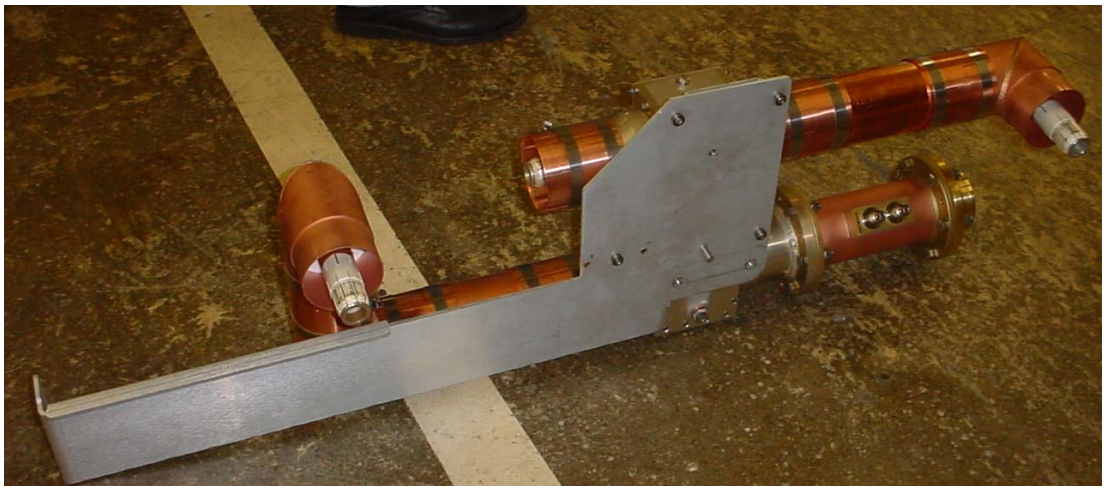

Figure 5-26 Hybrid Combiner/Coaxial RF System

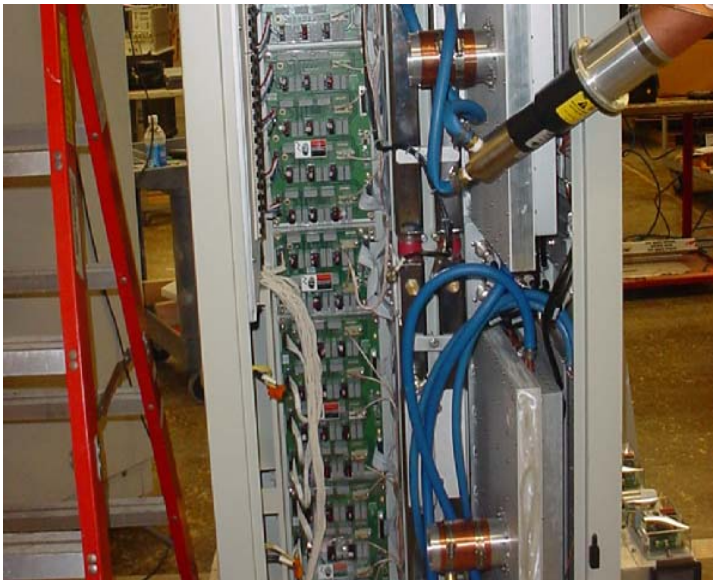

Figure 5-27 Cabinet with RF System Removed

STEP 14 **Reverse the procedure to reinstall the cabinet RF system.**

STEP 15 **End of procedure.**

5.13 Cooling System Maintenance

Inspect the coolant level and check for leaks frequently.

5.13.1 Heat Exchanger Cleaning

The heat exchanger fins should be examined for dust and dirt buildup monthly. Clean as needed with a low pressure water hose, soft bristled brush and vacuum or low pressure compressed air.

Caution

TAKE CARE NOT TO DAMAGE THE FINS. DO NOT CLEAN WITH HIGH PRESSURE WATER, A WIRE BRUSH OR USE OTHER METHODS THAT MIGHT DAMAGE THE FINS.

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5.13.2 Alternate Pumps

Every one or two months select the opposite pump in order to keep both pumps in a proper working state. Switching the pumps can be accomplished via the GUI screen (with pump module in REMOTE mode) by navigating to TCU HOME> SYSTEM then pressing the button for the inactive pump. This can also be done with the pump module in LOCAL by turning the desired pump switch to the on position.

5.13.3 Coolant Valve Maintenance

Every two months, during an off air period, the pump module should be turned off and the cooling system valves should be opened and closed several times to assure proper movement and closure. This prevents the valves from becoming stuck in one position.

Note

See the cooling system drawings, manufacturers component manuals and the pump module manual for details.

5.13.4 Pump Module Strainer Cleaning

The strainer assembly shown in Section Figure 5-28 on page 5-35 is located on the pump module in the return line (from heat exchanger). The strainer should be opened and cleaned after each flush in the start up process. The frequency of inspection after initial installation may vary depending on site conditions but in most cases semi-annual inspection and cleaning of the cooling system strainer is recommended. The strainer must be disassembled and cleaned when the transmitter is off air since coolant flow must be stopped before opening the strainer assembly. Follow the steps below to clean the strainer:

STEP 1 **Turn off the transmitter and pump module.**

STEP 2 **Close the ball valve just above the strainer assembly and both pump inlet valves to isolate the strainer from the rest of the cooling system.**

Caution

WEAR SUITABLE PROTECTIVE GLOVES AND EYE PROTECTION WHEN REMOVING THE STRAINER CAP. LOOSEN THE PLUG/DRAIN CAP SLOWLY SINCE THE COOLANT MAY BE UNDER PRESSURE. THE COOLANT MAY ALSO BE HOT.

STEP 3 **Remove strainer housing cap.** See note below.

Note

A small amount of liquid will still be present in the pipe and strainer housing, and a receptacle (bucket) will be necessary to contain the spillage.

STEP 4 **Pull strainer screen**

STEP 5 **Inspect and clean strainer as needed**

STEP 6 **Replace the strainer, and perform the above steps in reverse order to restore the cooling system to normal operation.**

STEP 7 **The system may need to be vented and or recharged after restart. Refer to the HE pump module manual for charging instructions.**

STEP 8 **End of procedure.**

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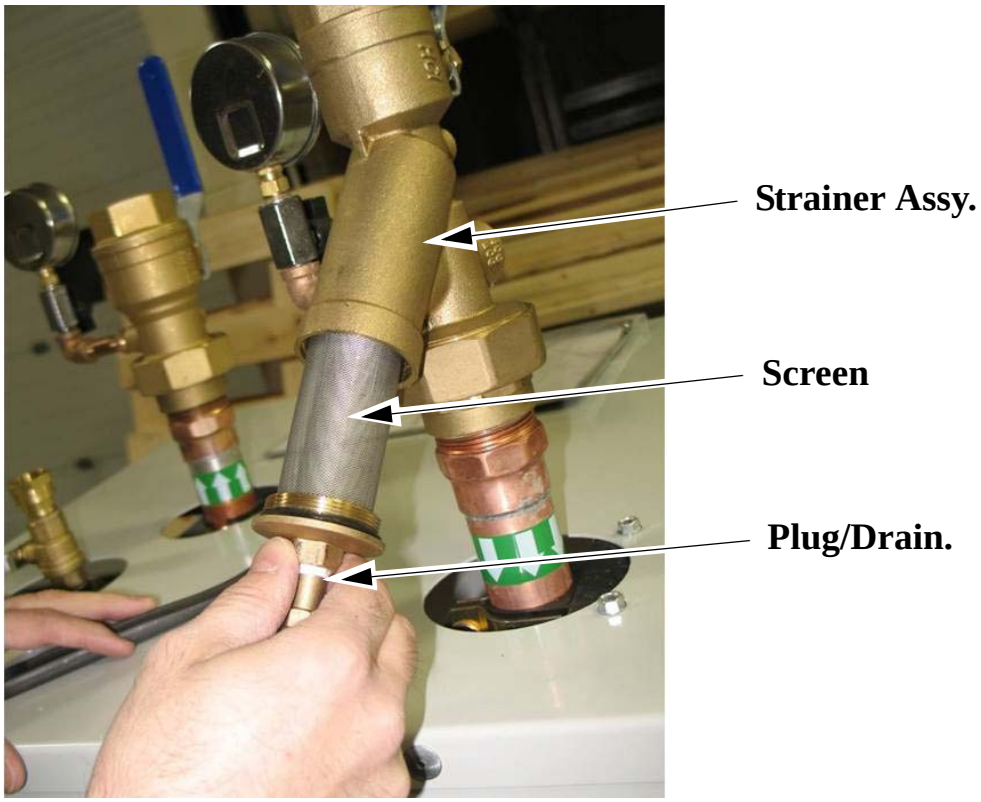

Figure 5-28 Strainer Assembly.

5.13.5 Coolant Level Management:

The Maxiva cooling system is a closed (pressurized) system. The system contains a pressurized expansion tank with a bladder that separates the system coolant from pressurized air. The expansion tank is pressurized at the factory and should not need pressurization on site. The coolant level is checked by viewing the coolant passing through the sight glass located on the air purger and located at the highest point in the cooling system. The presence of air bubbles or lack of fluid in the sight glass is an indication that the system needs to be charged with additional coolant.

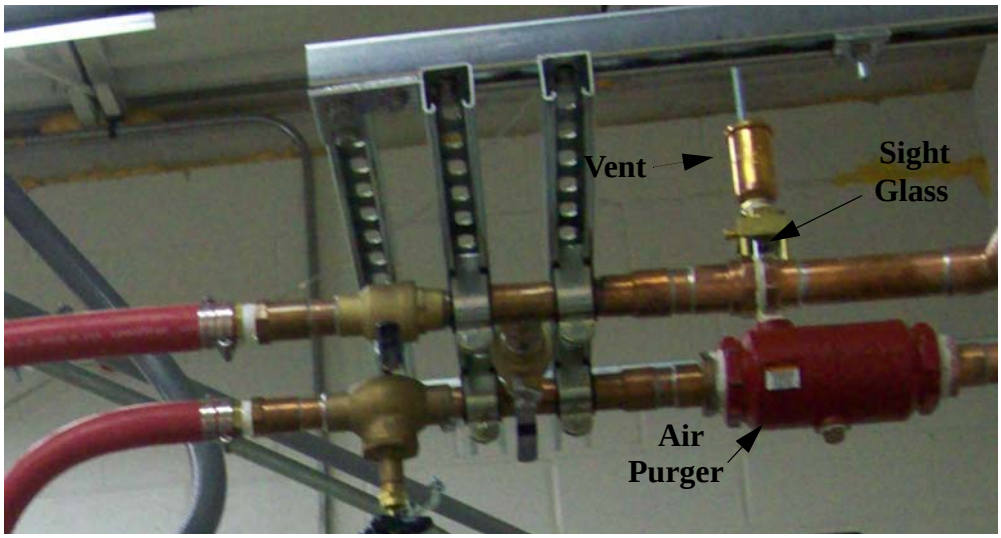

Figure 5-29 Air Purger and Sight Glass

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5.13.6 Coolant Maintenance

The pH level of the 50/50 glycol/water mixture should be above 8.0. A PH level that is below 8.0 indicates that the inhibitors in the glycol are ineffective. Should the PH level of the mixture drop below 8.0 either additives must be added or the coolant should be changed. The PH level should be checked quarterly with either pH paper or with a pH meter. If these test items are not available a sample of the coolant can be sent to an independent laboratory for analysis. The pH level and the 50/50 glycol/water ratio should both be checked at 3 month intervals.

5.13.7 Changing Pumps

STEP 1 **If possible turn off the transmitter and pump module.** This is the safest approach. If turning off the transmitter and pump module is not desirable the bad pump can be changed while the good pump is in service.

STEP 2 **Turn off the pump module circuit breaker associated with the pump to be replaced.**

STEP 3 **Close the ball (isolation) valves on either side of the pump that is to be changed.**

STEP 4 **Disconnect the fittings on either side of the pump.**

Note

A small amount of liquid will still be present in the pipe and pump housing, and a receptacle (bucket) will be necessary to contain the spillage.

Warning

WEAR SUITABLE PROTECTIVE GLOVES AND EYE PROTECTION WHEN REMOVING THE FITTINGS. LOOSEN FITTINGS SLOWLY SINCE THE COOLANT MAY BE UNDER PRESSURE. THE COOLANT MAY ALSO BE HOT.

STEP 5 **Remove and replace the pump. Take care to install the pump so the direction of flow is maintained in the proper direction.**

Caution

USE PIPE JOINT COMPOUND OR TEFLON TAPE ON MALE THREADED FITTINGS AS REQUIRED PRIOR TO REINSTALLATION OF PUMP. USE JOINT COMPOUND SPARINGLY TO AVOID CONTAMINATION OF COOLANT. IF FITTINGS WITH O-RING SEALS ARE USED THE O-RINGS SHOULD NOT BE REUSED. USE A NEW O-RING AND LUBRICATE IT LIGHTLY WITH SILICON GREASE.

STEP 6 **Perform the above steps in reverse order to restore the cooling system to normal operation.**

STEP 7 **Once system operation is restored check the sight glass to be sure that air bubbles are not present and that the level of coolant is adequate. Charge system as required to maintain coolant level.**

STEP 8 **End of procedure.**

5.13.8 Pump Module Operation Without Transmitter

The pump module can be operated independently, without being attached to the transmitter, by selecting the LOCAL mode on the pump module/heat exchanger cooling control panel.

Caution

SELECTION OF LOCAL WILL ALSO ALLOW THE PUMP MODULE/HEAT EXCHANGER TO BE OPERATED FROM THE CONTROL PANEL AS LONG AS THE PUMP INTERLOCK IS NOT ACTIVE.

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5.13.9 Air Filter Replacement

Monthly inspection and cleaning of the air filter is recommended. The filter can be easily removed from the rear door without tools.

Figure 5-30 Filter in Rear Door

STEP 1 **Open cabinet rear door to eliminate suction on filter material.**

STEP 1 **Grasp filter material or filter frame with fingers and lift upward until filter frame clears the lower edge of the door opening.**

STEP 2 **Pull lower part of filter through the door opening.**

STEP 3 **Slide the filter assembly downward and away from the door to remove.**

Figure 5-31 Filter Being Removed from Rear Door

STEP 4 **Clean with compressed air, wash with detergent/water and allow to dry, or replace as necessary**

STEP 5 **Reinstall dry filter by reversing the order of the above steps.**

STEP 6 **End of procedure.**

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5.13.10 Leak Detector and Cabinet Drains

A leak detector is installed at the bottom of the cabinet. The leak detector is shown in Figure 5-1 on page 5-38. It is mounted in the bottom cabinet near the center. The leak detector consists of a small reservoir with a float. The TCU monitors this leak detector to alert the system should a leak occur. A leak detection will cause the transmitter and the pump to be shut off by activating the pump interlock signal. In order to reset the leak detector the float assembly must be removed and a drain plug removed. Removing the drain plug allows the reservoir to drain into the drip pan at the bottom of the cabinet. Once the reservoir is drained and the leak detector assembly reinstalled the transmitter can be restarted by pressing the ON button on the front of the TCU.

The cabinet can be emptied of coolant by first turning off the pumps, closing the inlet and outlet valves at the top of the transmitter and then opening the fittings at the end of the supply and return side drain hoses inside the cabinet. Use a 7⁄16" open end wrench to open the drain valves.

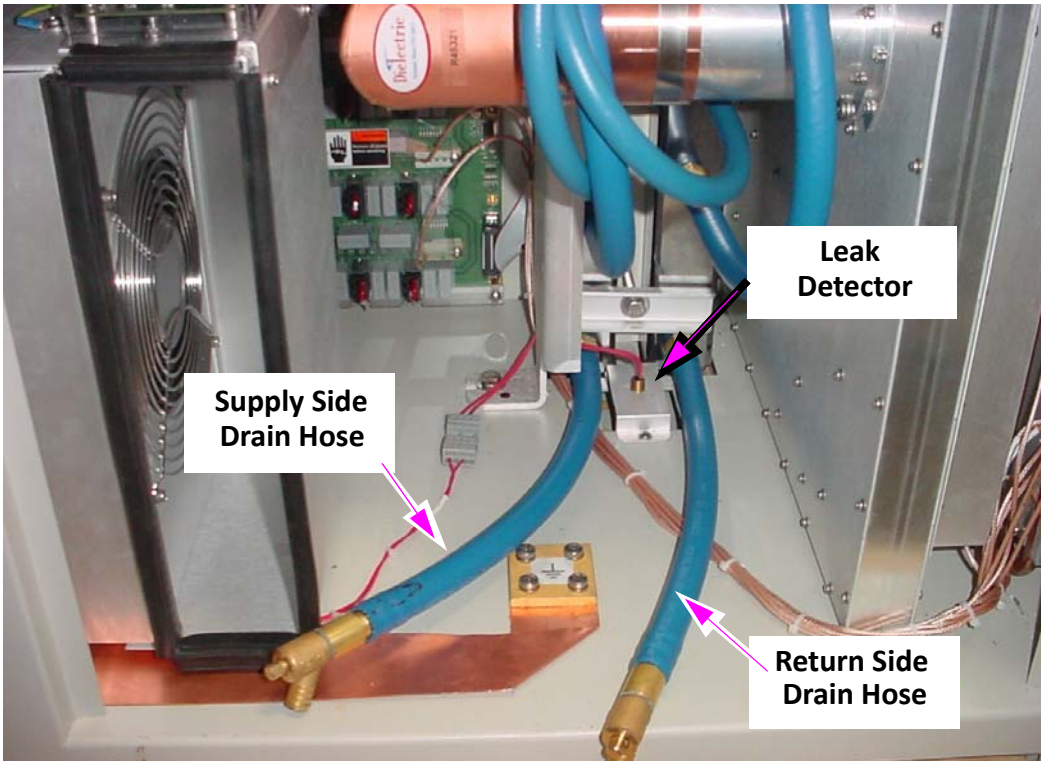

Figure 5-1 Leak Detector and Cabinet Drains

5.14 TCU Maintenance

5.14.1 TCU MCM and PCM-2 Software Uploads

TCU MCM and PCM-2 software uploads are covered in Section 3.9.3.4, Software Management, on page 3-31.

5.14.2 Panel PC Touch Screen Contrast

The panel PC GUI screen contrast is not adjustable.

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5.14.3 Panel PC Touch Screen Calibration

The GUI touchscreen has been calibrated at the factory. Should calibration become necessary, the calibration screen can be accessed by switching the TCU panel PC touch screen display off for fifteen seconds then back on. The on/off rocker switch is shown in Figure 5-32 and is located behind the TCU front panel, on the lower left side of the panel PC display unit, behind the filter material. It can be accessed by pulling the front panel outward and then downward before reaching into the opening behind the panel.

Once the display is switched back on, watch the screen closely. After approximately forty seconds a line of text stating "Touch the screen to begin calibration" will be displayed (briefly). Once this line is displayed, the user must touch the screen to begin the five press calibration process. Simply press the small Xs as they appear. Be careful not to double tap the Xs or you will corrupt the calibration and have to reboot to restart the calibration process.

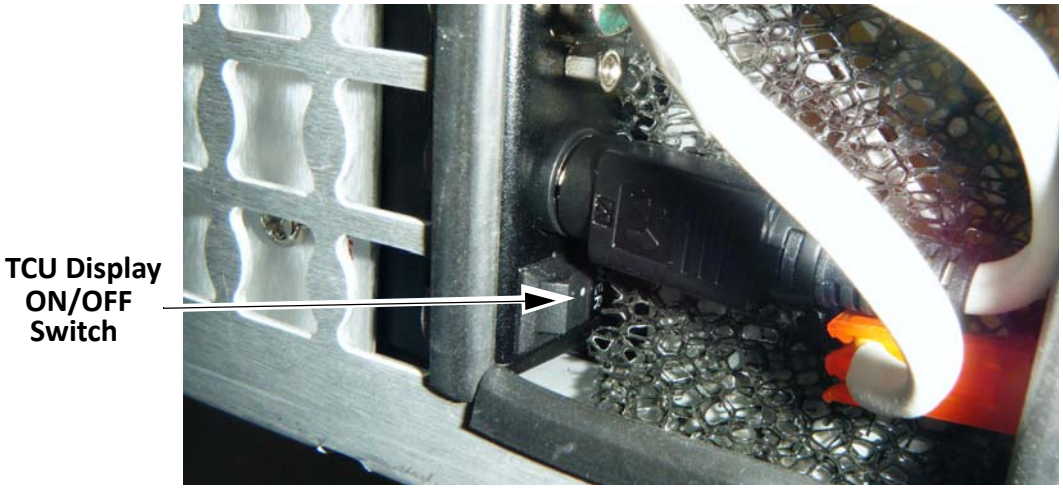

Figure 5-32 TCU Display Reset Switch

The panel PC display unit can also be rebooted in the event of a problem. The unit can be turned off for fifteen seconds and then switched back on. Rebooting the panel PC does not affect transmitter operation and can be done with the transmitter on air.

5.14.4 Date and Time Settings

Date and time settings can be performed using the local GUI screen. See Figure 3-24 on page 3-22 which shows the local GUI service screen and Table 3-9 on page 3-22, which explains the date and time setting.

5.14.5 Changing the PCM Card Battery

Transmitter control units (TCU's) are shipped as components in several different Harris transmitter models. The TCU will contain different printed circuit cards depending on the transmitter application. TCU's that have GUI (graphical user interface touch screen) displays will contain a PCM card. The PCM card is the second card from the right when looking at the front of the TCU.

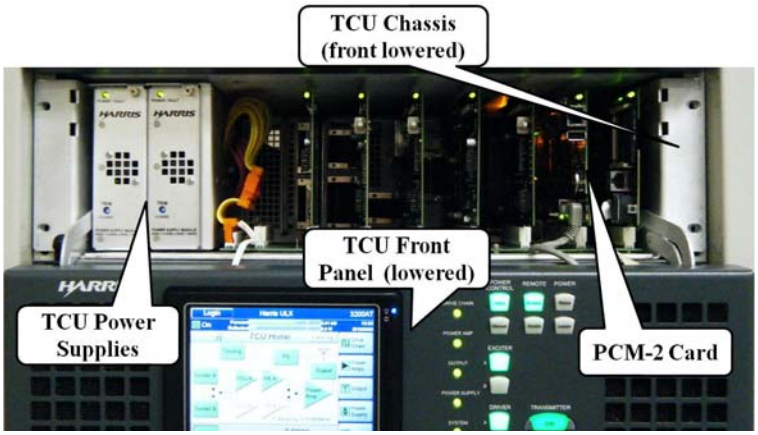

Figure 5-33 TCU with front panel lowered

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The PCM card contains a battery that is used for the real time clock in the TCU. The battery powers real time clock circuitry to maintain the clock time/date when the unit does not have AC power applied. The unit is typically shipped with the battery removed from the PCM card. The battery should be installed before the transmitter goes into operation.

The clock battery (part number 660-0093-000 for older PCM-1 cards and 660-0054-000 for more recent PCM-2 models) is packed inside a plastic bag that contains battery replacement instructions. Once the transmitter is installed and AC power has been connected the clock battery should be installed in the PCM card.

5.14.5.1 PCM-2 Battery Installation Instructions

STEP 1 **Turn off the transmitter and remove power from the transmitter cabinet or disconnect the AC plug(s) from the rear of the TCU.**

Caution

TCU CARDS ARE NOT HOT SWAPPABLE. THE TRANSMITTER SHOULD BE OFF AND THE POWER DISCONNECTED FROM THE TCU BEFORE REMOVAL OF CARDS.

STEP 2 **Use the finger hole cut outs built into the sides of the TCU front panel as handles, pull outward and down on the front cover.**

STEP 3 **Locate the battery holder on the PCM-2 card. Location is shown in figure 5-34.**

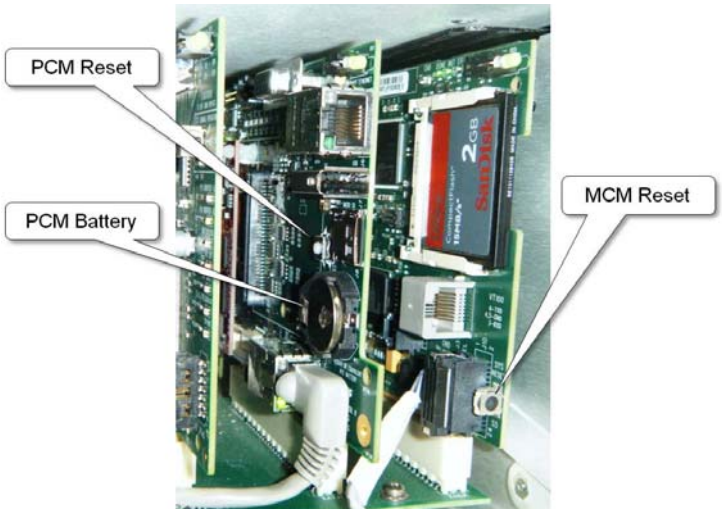

Figure 5-34 PCM-2 Battery and Holder

STEP 4 **Use a small flat blade screw driver to gently pry open the battery hold down clip while sliding the battery under the clip. The + side of the battery must installed closest to the battery clip, i.e. the + side must point away from the board. The installed battery is shown in figure 5-34.**

STEP 5 **Close front panel.**

STEP 6 **Reapply AC power.**

STEP 7 **Reset time and date as needed. See section 5.14.4 on page 5-39.**

STEP 8 **End of procedure.**

5.14.5.2 PCM-1 Battery Installation Instructions

STEP 1 **Turn off the transmitter and remove power from the transmitter cabinet or disconnect the AC plug(s) from the rear of the TCU.**

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Caution

TCU CARDS ARE NOT HOT SWAPPABLE. THE TRANSMITTER SHOULD BE OFF AND THE POWER DISCONNECTED FROM THE TCU BEFORE REMOVAL OF CARDS.

STEP 2 **Use the finger hole cut outs built into the sides of the TCU front panel as handles, pull outward and down on the front cover.**

STEP 3 **Remove four rack mounting fasteners from the each sides of the TCU front.**

STEP 4 **Pull the TCU chassis out of the rack as far as the slides allow.**

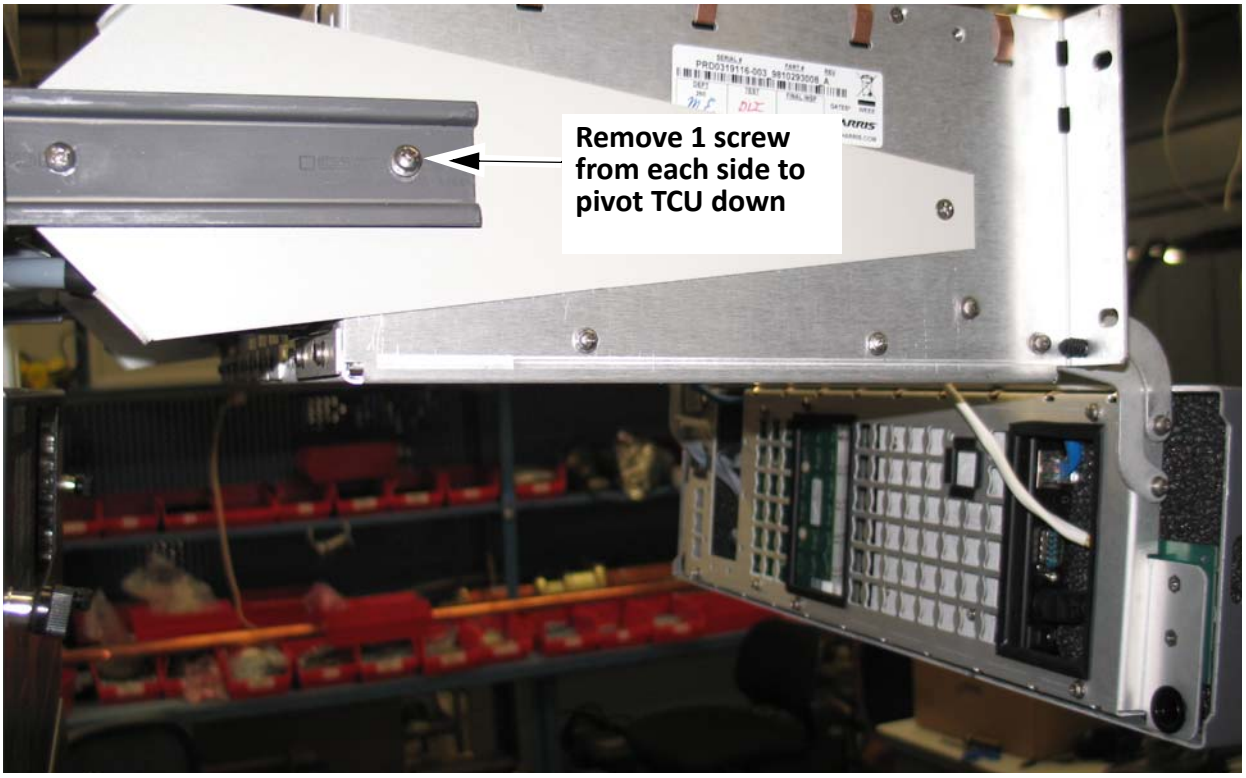

Figure 5-35 TCU Slide Brackets

STEP 5 **The TCU can be pivoted downward for easier access to the cards. This is done by removing the front screw (shown in figure 5-35) on either side of the TCU slide brackets.**

Caution

THE TCU MUST BE SUPPORTED WHILE REMOVING THESE SCREWS TO KEEP IT FROM FALLING DOWNWARD RAPIDLY.

STEP 6 **Remove the TCU cover.**

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Figure 5-36 TCU Pivoted Downward

Note

Use a stool or step ladder to allow easier access to the top of the TCU unit if needed.

STEP 7 **Locate the battery holder on the PCM-1 card.** Location is shown in figure 5-37.

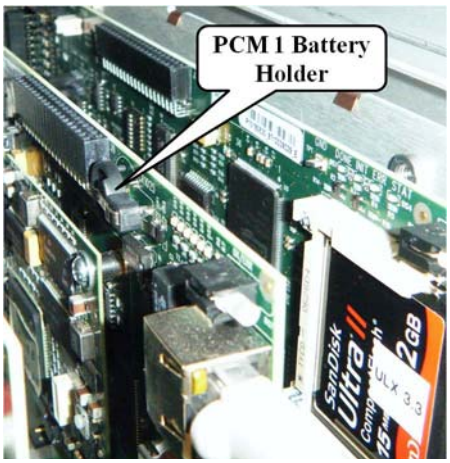

Figure 5-37 PCM-1 Battery Holder

STEP 8 **Use a small flat blade screw driver to gently pry open the battery hold down clip while sliding the battery under the clip. The + side of the battery must installed closest to the battery clip, i.e. the + side must point away from the board.**

STEP 9 **Replace the top cover.**

STEP 10 **Close front panel.**

STEP 11 **Pivot TCU upward and reinstall the screw on each side of the slide bracket.**

STEP 12 **Slide the TCU back into the rack.**

STEP 13 **Install and tighten the rack mount fasteners.**

STEP 14 **Reapply AC power.**

STEP 15 **Reset time and date as needed. See section 5.14.4 on page 5-39**

STEP 16 **End of procedure.**

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5.14.6 TCU Card Replacement

Should it become necessary to change cards in the TCU use the following procedure:

STEP 1 **Go to the System>Service>Version screen and note the revision levels of the PCM and MCM cards if they are going to be changed.**

STEP 2 **Turn off the transmitter and disconnect power from the transmitter cabinet or disconnect the AC plug(s) from the rear of the TCU.**

STEP 3 **Use the finger hole cut outs built into the sides of the TCUfront panel as handles, pull outward and down on the front cover.**

STEP 4 **Remove four rack mounting fasteners from the each sides of the TCU front.**

STEP 5 **Pull the TCU chassis out of the rack as far as the slides allow.**

STEP 6 **The TCU can be pivoted downward for easier access to the cards. This is done by removing the front screw (shown in figure 5-35) on either side of the TCU slide brackets.**

Warning

THE TCU MUST BE SUPPORTED WHILE REMOVING THESE SCREWS TO KEEP IT FROM FALLING DOWNWARD RAPIDLY.

STEP 7 **Remove the TCU cover to gain easier access to the TCU cards.**

STEP 8 **Remove connectors from the rear of the card that is being changed.**

STEP 9 **Use a short #2 Phillips screwdriver to remove the mounting screw from the back of each module (near the bottom).**

STEP 10 **Lift the board out of the slot and replace with new board.**

Note

If the MCM card is changed the flash drive card should be removed from the old board and installed in the new board. This will allow the system to retain previously stored calibration values.

STEP 11 **Reverse the steps to reconnect and reinstall the TCU.**

STEP 12 **Turn the TCU on and after boot up, verify that the software on the new board is the same as was on the board that was removed.**

STEP 13 **End of procedure**

5.14.7 MCM Card Replacement

Follow the instructions given in 5.14.6 on page 5-43 for TCU card removal.

The MCM card in the TCU contains several jumpers, a cabinet selector switch (S1 rotary), and a toggle switch used to select VT-100 or DNLD inputs. Should the MCM card need to be replaced the following jumpers should be set to the same values as the original board. Blue jumper settings that should be checked are:

JP1	1-2
JP2	1-2
JP4	2-3
JP5	1-2
JP6	1-2
JP7	2-3
JP8	2-3

Rotary Switch (Cabinet ID S1):

Switch should be set to 1 for cabinet 1, 2 for second cabinet, etc.

DNLD/VT100 (toggle switch S2):

Set to VT100 if VT100 is connected to RS-232 port.

Note

If the MCM card is changed the flash drive card should be removed from the old board and installed in the new board. This will allow the system to retain previously stored calibration values.

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5.14.8 TCU PS Module Maintenance and Replacement

The TCU PS Modules (front) are shown in Figure 5-33 on page 5-39. The PS modules supply the required voltages to the TCU cards and front panel. The PS modules are not hot pluggable.

The TCU power supply modules should be checked periodically to be sure that there is not excessive dirt built up on the fan cover. If dirt build up is evident use a vacuum cleaner to clean off the front cover. The filters in the TCU front panel should also be checked and cleaned as needed. The filters are washable and can be removed from the front panel, washed with soap and water, dried thoroughly and then replaced.

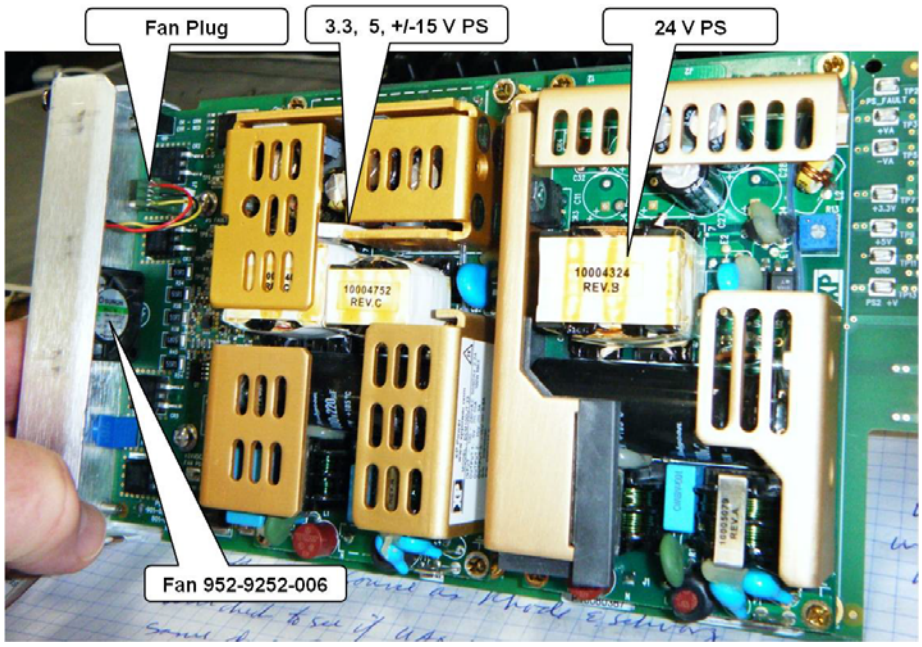

Figure 5-38 TCU PS Module Fan

During the periodic inspections be sure that the fan is operating efficiently. The fan draws air into the PS module. With the TCU operating, hold a small strip of paper directly in front of each PS fan and be sure it is pulled in toward the PS face. If the fan is not functioning properly it should be changed. Simply remove the PS from the TCU using the instructions that follow, unplug the fan, remove the two screws that hold the fan on the front cover, and remove the fan. The replacement fan part number is 952-9252-006.

STEP 1 **Disconnect TCU from AC mains power source. This can be accomplished by disconnecting the appropriate AC plug on the TCU rear panel or by turning off the Control 1 circuit breaker for PS 1 (next to the cabinet wall) or Control 2 circuit breaker for PS 2.**

STEP 2 **Use a #1 Phillips screwdriver to loosen the single fastener on the top front of the PS module. When the fastener is loose use it to pull the module out of the TCU chassis.**

Note

A faulty power supply could be safely removed from the TCU chassis while the TCU is energized but the PS should never be installed without removing AC power from the TCU. Plugging the replacement PS into an active TCU could permanentlydamage the PS card edge.

STEP 3 **Slide the replacement PS module into the TCU chassis taking care to align the upper and lower edges in the chassis alignment slots. Be sure the PS module connectors line up and seat into the connector in the rear of the TCU chassis.**

STEP 4 **Tighten the fastener on the top front of the PS module.**

STEP 5 **Apply AC mains power to the TCU. The green LED on the upper, left, front, of the PS module should light.**

STEP 6 **End of procedure.**

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5.14.9 TCU Air Filters

The TCU front panel contains two filters (943-5600-109)that should be inspected periodically for dust buildup. Lower the TCU front panel, use a #2 Phillips screwdriver to remove the four TCU chassis mounting screws, and pull the TCU out of the rack using built in slides. Then use a #1 Phillips screwdriver to remove the six screws that hold the front panel to the front panel chassis. After the six screws are removed tip the front panel forward and then upward to disconnect the two tabs at the base of the front panel chassis from the slots in the front panel. Disconnect the Ethernet connector from the PCM card and the power connector from the panel PC to allow removal of the front panel. The filters can now be removed, washed with water, dried and replaced. Dry the filters thoroughly before reinstalling them.

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5.15 Typical Analog Test Equipment

Table 5-6 Recommended Test Equipment

Equipment Type	Manufacturer	Model Number	Options	Harris Part No. (if applicable)
TV Demodulator	Tektronix	1350		
Video Generator	Phillips	PM 5646		
	Tektronix	1910, TPG20, or equal alternate		
Waveform Monitor	Tektronix	1780/81 or VM700		
Vectorscope	Tektronix	1780/81, VM700 or equal alternate		
Aural Stereo Test Generator	RE Instruments	RE540		
Aural Stereo Monitor	Tektronix	751		
	TFT	850		
Audio Measurement Set	Audio Precision	Portable 1		
	Potomac	AA-51 or AG-51		
Envelope Delay Measuring Set	Tektronix	VM700		
	Asaca	201-1 NTSC or 201-2 PAL		
Spectrum Analyzer	Tektronix	2712, 2792, 2794, or 2750		
Optional: Network Analyzer	Agilent	HP 8753C	041 Printer option and 099 H38W tracking generator LO (for sweep and tune)	
Spectrum Analyzer Or	Agilent	8591E, or its replacement the, 4402B	H38 LO output (for sideband adaptor) 010 tracking generator output 043 RS232 and parallel printer port Resolution: 30 Hz to 3 MHz	
	Tektronix	FSEA20, or other equivalent to the HP above.		
Power measurement	Agilent	E44182B power meter with E9300B sensor, 100 uW to 3 W		
Frequency measurement Or	Agilent	53131A or 53181A	010 high stability time base 015 range extension to 1.5 GHz, OR 030 range extension to 3.0 GHz	
	Tektronix	CMC251		
Miscellaneous Test Equipment	400 MHz dual trace Oscilloscope			
	Camera or software package to record transmitter performance data			
	Bird	APM-16 wattmeter, with 1W to 1kW elements		
	Narda	Directional coupler		620-0457-000
	Eagle	RLB-150 RF bridge		700-1289-000
	Eagle	TNF-200 UHF RF notch filter		484-0300-000
	Fluke	87 digital multimeter with 801-400 current probe		
	Or	Any true RMS multimeter		
		Power supply, 0-6 A constant current, 0 to 24 volt rang		
Optional Adapters and connectors	Myat	3-1/8 inch to 4-1/16 inch adaptor		620-2395-000
	Dielectric	3-1/8 inch to 4-1/16 inch adaptor		620-1928-000
	Myat	3-1/8 inch to 6-1/8 inch adaptor		620-2297-000
		3-1/8 inch to type N adaptor		620-2859-000

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Table 5-6 Recommended Test Equipment

Equipment Type	Manufacturer	Model Number	Options	Harris Part No. (if applicable)
Adapters and connectors		Type N to BNC, male to female		620-0128-000
		Type N to BNC, female to male		620-0547-000
		BNC barrel, female to female		620-0604-000
		BNC barrel, male to male		620-0564-000
		SMA to BNC, male to female		620-2611-000
		SMA to N, male to female		620-2562-000
		SMB (push on) to BNC		620-0628-000
		SMC to BNC, screw on jack to plug		620-2563-000
		BNC to TNC, jack to plug		620-2821-000
		BNC to TNC, jack to jack		620-2823-000
		TNC to N, plug to jack		620-2824-000
		TNC to N, jack to plug		620-2822-000
Attenuator		10 dB attenuator, type N, male to female		556-0074-000

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5.16 Typical Digital Test Equipment

Table 5-7 Recommended Test Equipment

Equipment Type	Manufacturer	Model Number	Options	Harris Part No. (if applicable)
TV Spectrum Analyzer	R&S	ETL	ETL-B203 RF pre-select.	
			FSL-B4 OCXO Ref. Freq.	
			FSL-B7 Nar. Res. Filters	
			ETL-K220 ATSC Demod.	
			DIV7 ETL-K208 Meas. Log	
Demodulator	R&S	EFA		instead of ETL
Spectrum Analyzer	Agilent	4402		instead of ETL
Power measurement	Agilent	E44182B power meter with E9300B sensor, 100 uW to 3 W		
Frequency measurement	Agilent	53131A or 53181A	010 high stability time base 015 range extension to 1.5 GHz, OR 030 range extension to 3.0 GHz	
Miscellaneous Test Equipment	Bird	APM-16 wattmeter, with 1W to 1kW elements		
	Narda	Directional coupler		620-0457-000
	Eagle	RLB-150 RF bridge		700-1289-000
	Eagle	TNF-200 UHF RF notch filter		484-0300-000
	Fluke	87 digital multimeter with 801-400 current probe		
Optional Adapters and connectors	Myat	3-1/8 inch to 4-1/16 inch adaptor		620-2395-000
	Dielectric	3-1/8 inch to 4-1/16 inch adaptor		620-1928-000
	Myat	3-1/8 inch to 6-1/8 inch adaptor		620-2297-000
		3-1/8 inch to type N adaptor		620-2859-000
Adapters and connectors		Type N to BNC, male to female		620-0128-000
		Type N to BNC, female to male		620-0547-000
		BNC barrel, female to female		620-0604-000
		BNC barrel, male to male		620-0564-000
		SMA to BNC, male to female		620-2611-000
		SMA to N, male to female		620-2562-000
		SMB (push on) to BNC		620-0628-000
		SMC to BNC, screw on jack to plug		620-2563-000
		BNC to TNC, jack to plug		620-2821-000
		BNC to TNC, jack to jack		620-2823-000
		TNC to N, plug to jack		620-2824-000
		TNC to N, jack to plug		620-2822-000
Attenuator		10 dB attenuator, type N, male to female		556-0074-000

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Section-6 Diagnostics 6

6.1 Introduction

This section contains diagnostic and troubleshooting information for the ULX series UHF transmitter. Included is a description of faults which can be displayed via the transmitter front panel TCU display or web GUI (Graphical User Interface). Due to the complexity of the transmitter control system and the extensive use of surface mount components, the scope of this diagnostics section is to isolate the problems down to a PC board or module, which can then be easily exchanged.

The GUI buttons and icons use a symbol and color code system. Some examples using the triangle shape are given below. The other shapes operate similarly.

a. Green with a 1 - - ON and operating normally.

b. Green symbol - - ON and operating normally.

c. Light Gray - - "Grayed Out" - Not communicating or not available.

d. Yellow -

Warning - A non-critical sub-system or parameter is out of tolerance and should be addressed by engineering personnel.

e. Red - - Critical Fault - This could be a sub-system fault in which the sub-system is muted or shut off (such as a PA Module) or could be a system level fault which could mute or shut the transmitter off.

When a fault occurs one or more of the LED's on the TCU will illuminate RED. To track down the cause of the fault, begin by looking at the TCU Home screen and the software buttons along the right side as shown in Figure 3-9, another option is to go to the Event Log and observe the listed faults and their order. If you are not familiar with GUI navigation, refer to Section 3.

6.2 Event Log

The GUI contains an event log which is a listing of events, warnings. and faults which have occurred. To see the event log press SYSTEM then EVENT LOG. This will bring up the screen in Figure 6-1. The System Log gives the following information:

a. **#** - This gives the number of the fault. There can be up to 1,000 faults in the event log, then it is FIFO (First IN, First Out). The TCU event log can be viewed in its entirety, printed, or exported by double clicking on the web browser screen event listing.
b. **Set** - Time (24 hour format) and date (month, day, year) that the fault occurred.
c. **Clear** - Time and date that the fault was cleared. If the fault is still active, the Clear field will be blank.
d. **Name** - Name and description of the fault.
e. **Active or Inactive** - If the fault is highlighted in red, it is still active and cannot be cleared. If the fault is not highlighted (gray), then the fault is gone and can be cleared if so desired. Yellow highlight indicates an active warning.

Function Buttons:

a. **CLEAR LOG** - Will erase all inactive faults, warnings and events in the log.
b. **NEXT and PREV -** These buttons allow you to scroll through the entire fault list if necessary.

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c. **BACK -** Will take you back to the TCU Home menu.

Note

Tables 6-1 and 6-2 lists transmitter faults. They also give a brief description of each fault, the trip point and the transmitter action taken in response to the fault.

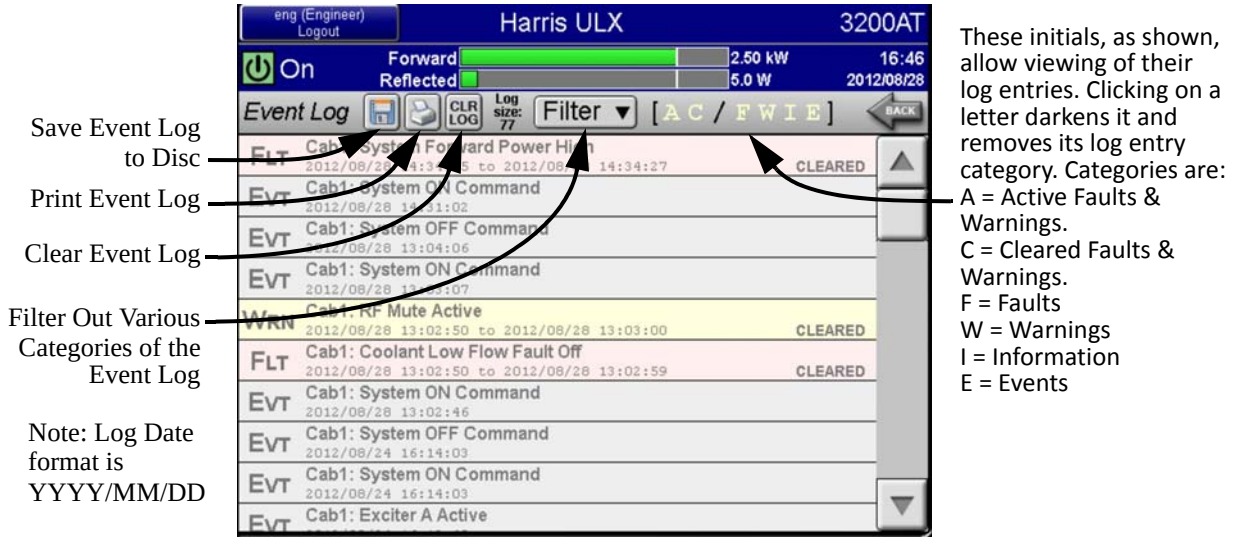

Figure 6-1 Event Log Screen

6.3 Maxiva Three-Strike Fault Actions

6.3.1 Reflected Power Faults

The TCU monitors reflected power at the cabinet output and at the system output. When the reflected power level (typically 10% of the rated power or a 1.9:1 VSWR) is exceeded the TCU generates an RF MUTE. If after three attempts to restart (three strikes) subsequent faults occur, the transmitter will turn OFF and operator intervention will be needed to turn it back ON. The three strike counter resets after 30 seconds with no faults. A VSWR warning is issued at a 1.4:1 VSWR level.

Reflected power faults that initiate a three strike procedure are:

- Cabinet Reflected Power
- System Reflected Power

6.3.2 Module Faults

Should a module failure occur (say a power glitch) the TCU will initiate a three-strike action. This action will cause a reset of only the PA Module experiencing the fault and not the entire transmitter.

The module three strike policy is:

- The TCU will try to restart the module three times within a 10 second window. After that, if a fault is still present, the module will be turned OFF until it receives the restart command from the Main Controller (ON Command).
- There is a 3 second delay between restart attempts.
- The fault-strike restart process is the same as the system restart command, all of the module faults will be reset.
- During the 10 second three-strike window, any of the nuisance faults will be reported to the Main Controller.

These are the module faults which will be allowed three strikes:

- Over Voltage Pallet

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- Under Voltage Pallet
- Over Temperature Module Controller
- Over Current Module Driver
- Over Temperature Pre-driver Heatsink
- Over Drive Module RF Input
- Over Drive Module RF Output
- Under Current Phase and Gain Board
- Over Current Phase and Gain Board
- Over Current Pallet
- Under Current Pre-Driver
- Over Current Pre-Driver
- Over Temperature Power Supply Board
- Low Voltage Output DC Converter
- Short Circuit
- High Module Reflected Power

6.4 Fault Tables

The following tables provide a listing of Maxiva Transmitter faults along with a brief description, the fault level or threshold and the action taken by the transmitter.

Table 6-1 Maxiva Drive Chain Fault List

TYPE	Description	Fault Level or Threshold	Transmitter Action	Three Strike	Available in Life Support
IPA A Fault: Power Supply, LDMOS, VSWR, Power Overload, Temperature, Input Power	The IPA can report up to 6 faults via their parallel control pins	Any one fault active	IPA Switch to alternate IPA if in Auto Mode	YES	YES
IPA B Fault: Power Supply, LDMOS, VSWR, Power Overload, Temperature, Input Power	The IPA can report upto 6 faults via their parallel control pins	Any one fault active	IPA Switch to alternate IPA if in Auto Mode	YES	YES
PDU (Predriver) A Fault	The Predriver current is monitored inside the PDU. A fault is sent if it is below the normal minimum current.	Predriver current is below TBD mA	IPA Switch to alternate IPA if in Auto Mode	NO	YES
PDU Predriver B Fault	The Predriver current is monitored inside the PDU. A fault is sent if it is below the normal minimum current.	Predriver current is below TBD mA	IPA Switch to alternate IPA if in Auto Mode	NO	YES
Exciter A Power Output	Exciter A power level low	Trip point is 50% of nominal. Trip point adjustable by epot	Exciter Switch to alternate Exciter if in Auto Mode	NO	YES
Exciter B Power Output	Exciter B power level low	Trip point is 50% of nominal. Trip point adjustable by epot	Exciter Switch to alternate Exciter if in Auto Mode	NO	YES
EXCA NO COMMUNICATIONS	Exciter A not communicating with transmitter main controller	No serial communications traffic detected	Exciter Switch to alternate Exciter if in Auto Mode	NO	NO
EXCB NO COMMUNICATIONS	Exciter B not communicating with transmitter main controller	No serial communications traffic detected	Exciter Switch to alternate Exciter if in Auto Mode	NO	NO
EXCA Summary Fault	Exciter A reports a summary fault	Exciter Switch to alternate Exciter if in Auto Mode	NO	YES	
EXCB Summary Fault	Exciter B reports a summary fault	Exciter Switch to alternate Exciter if in Auto Mode	NO	YES	

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Table 6-2 PA and IPA Module Fault List

TYPE	Description	Fault Level or Threshold	Transmitter Action	Three Strike	Available in Life Support
Temperature	Temperature fault	Pallet temp >90°C. Monitor temp >65°C.	Red LED. No RF out of module.	YES	YES
VSWR	VSWR fault	Reflected power > 160W average (digital).	Red LED. No RF out of module.	YES	YES
Overload (including Input Power Overdrive)	Power overload (including input power overdrive)	Input >55.7W peak. Output > 2219W peak.	Red LED. No RF out of module.	YES	YES
LDMOS	LD-MOSFET failure	LDMOS current < .5A	Red LED. Reduced RF out of module.	YES	YES
RF Input OK	RF input low or ok.	RF input <.16W	Red LED if low. Green if ok.	YES	YES
Power Supply	PS failed	PS voltage <40W	Red LED if low.	NO	YES

Table 6-3 Power Supply Faults List

TYPE	Description	Fault Level or Threshold	Transmitter Action	Three Strike	Available in Life Support
+VA VDC FLT	+15V Voltage Failure	Value is more than +/-15% of normal reading	WARNING	NO	YES
-VA VDC FLT	-15V Voltage Failure	Value is more than +/-15% of normal reading	WARNING	NO	YES
+5 VDC FLT	+5V Voltage Failure	Value is more than +/-15% of normal reading	WARNING	NO	YES
+3.3 VDC FLT	+3.3V Voltage Failure	Value is more than +/-15% of normal reading	WARNING	NO	YES
AC Mains High	AC Mains voltage has exceeded 10% above nominal		WARNING	YES	YES
AC Mains Low	AC Mains voltage has exceeded 15% below nominal		WARNING	YES	YES
AC Phase Imbalance	AC line imbalance phase to phase	Any phase is greater than +/-5% of the average of all three phases	WARNING	NO	YES
AC Phase Sequence	Wrong Phase sequence detected		RF MUTE, Pump and Heat exchanger turned OFF. Transmitter returns to ON state automatically when fault clears.	NO	YES
MOV Fuse 1	Fuse failed on MOV board	FUSE OPEN	WARNING	NO	YES
MOV Fuse 2	Fuse failed on MOV board	FUSE OPEN	WARNING	NO	YES
MOV Fuse 3	Fuse failed on MOV board	FUSE OPEN	WARNING	NO	YES
MOV Fuse 4	Fuse failed on MOV board	Value is more than +/-15% of normal reading	WARNING	NO	YES

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Table 6-4 Output Faults List

TYPE	Description	Fault Level or Threshold	Transmitter Action	Three Strike	Available in Life Support
Cabinet VSWR (Reflected Power Fault)	Cabinet Reflected Power has exceeded 10% of rated power	Trip point is set at VSWR = 1.9:1. Trip point adjustable by epot	RF MUTE, Fault OFF after 3-strike. The Time interval between strikes should be about 3 seconds	YES	YES
System VSWR (Reflected Power Fault)	System Reflected Power has exceeded 10% of rated power	Trip point is set at VSWR = 1.9:1 (Foldback starts at 1.4:1). Trip point adjustable by epot. Foldback set point adjustable by software	RF MUTE, Fault OFF after 3-strike. The Time interval between strikes should be about 3 seconds	YES	YES for trip NO for foldback. Foldback routine requires PCM action
Cabinet Forward Power Fault (Visual Power in Analog TV)	Cabinet Forward Power has exceeded 10% of rated power	WARNING	NO	YES	YES
Cabinet Aural Power Fault (Analog TV only)	Aural Power is below 50% of rated power	WARNING	NO	NO	NO
System Forward Power Fault	System Forward Power has exceeded 10% of rated power	WARNING	NO	YES	YES
System Aural Power Fault (Analog TV only)	Aural Power is below 50% of rated power	WARNING	NO	NO	NO
System Power Foldback	The forward power is folded back (reduced) to maintain the reflected power below 2.8% of nominal power (1.4:1 VSWR)	Trip point is set at VSWR = 1.4:1. This is a software trip point which depends on the transmitter nominal power	WARNING	NO	NO
Reject 1 Fault	Reject power threshold exceeded	WARNING	NO	YES	YES
Reject 2 Fault	Reject power threshold exceeded	WARNING	NO	YES	YES
Reject 3 Fault	Reject power threshold exceeded	WARNING	NO	YES	YES

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Table 6-5 System Faults List

TYPE	Description	Fault Level or Threshold	Transmitter Action	Three Strike	Available in Life Support
Air Temp	Ambient control enclosure air temperature has exceeded 65°C. The source of this temp can be from the temp sensor in the MCM module for instance.	65°C	WARNING	NO	YES
Coolant Flow	Coolant flow is less than the minimum Liters per minute flow rate for the number of PAs present	Depends on transmitter model	RF MUTE followed by pump switchover. If still insufficient flow RF MUTE stays active until proper flow is restored. Transmitter returns to ON state automatically when fault clears.	NO	YES
Coolant Leak	Coolant leak detected inside transmitter cabinet	N/A	Transmitter Fault OFF. A manual turn ON is required for recovery	NO	YES
Coolant Inlet Temperature	Coolant temperature has exceeded 55°C	Warning at 55°C, Fault at 65°C	WARNING. RF MUTE if coolant temperature reaches 65°C. Transmitter returns to ON state automatically when fault clears.	NO	YES
Coolant Outlet Temperature	Coolant temperature has exceeded 55°C	Warning at 55°C, Fault at 68°C	WARNING. RF MUTE if coolant temperature reaches 68°C. Transmitter returns to ON state automatically when fault clears.	NO	YES
Coolant Fault	The tank in the pump module is empty	Open circuit from level detector inside tank	Transmitter Fault OFF. A manual turn ON is required for recovery	NO	YES
Coolant Warning	The coolant in the tank is low	Open circuit from level detector inside tank	WARNING	NO	YES
Fan 1 Fault	Fan AC current too low or too high	Fault levels LOW: 100 mA, HIGH: 800 mA	WARNING	NO	YES
Fan 2 Fault			WARNING	NO	YES
System Safety Interlock		Open circuit	Transmitter Fault OFF. A manual turn ON is required for recovery	NO	YES
System RF Mute Interlock		Open circuit	Transmitter RF MUTE. Transmitter returns to ON state automatically when the interlock is closed.	NO	YES
Cabinet Safety Interlock		Open circuit	Cabinet Fault OFF. A manual turn ON is required for recovery	NO	YES
Cabinet RF Mute Interlock		Open circuit	Cabinet RF MUTE. Cabinet returns to ON state automatically when the interlock is closed.	NO	YES

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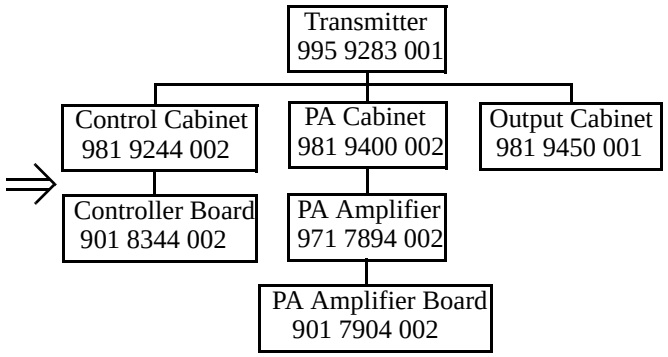
Section-7 Parts List 7

Guide to Using Parts List Information

The Replaceable Parts List Index portrays a tree structure with the major items being left most in the index. The example below shows the Transmitter as the highest item in the tree structure. If you were to look at the bill of materials table for the Transmitter you would find the Control Cabinet, the PA Cabinet, and the Output Cabinet. In the Replaceable Parts List Index the Control Cabinet, PA Cabinet, and Output Cabinet show up one indentation level below the Transmitter and implies that they are used in the Transmitter. The Controller Board is indented one level below the Control Cabinet so it will show up in the bill of material for the Control Cabinet. The tree structure of this same index is shown to the right of the table and shows indentation level versus tree structure level.

Example of Replaceable Parts List Index and equivalent tree structure:

Replaceable Parts List Index	Part Number	Page
Table 7-1. Transmitter	995 9283 001	7-2
Table 7-2. Control Cabinet	981 9244 002	7-3
Table 7-3. Controller Board	901 8344 002	7-6
Table 7-4. PA Cabinet	981 9400 002	7-7
Table 7-5. PA Amplifier	971 7894 002	7-9
Table 7-6. PA Amplifier Board	901 7904 002	7-10
Table 7-7. Output Cabinet	981 9450 001	7-12



The part number of the item is shown to the right of the description as is the page in the manual where the bill for that part number starts. Inside the actual tables, four main headings are used:

- Table #-#. ITEM NAME - PART NUMBER - this line gives the information that corresponds to the Replaceable Parts List Index entry;
- PART NUMBER column gives the ten digit Harris Broadcast part number (usually in ascending order);
- DESCRIPTION column gives a 25 character or less description of the part number;
- REF. SYMBOLS/EXPLANATIONS column 1) gives the reference designators for the item (i.e., C001 R102 etc.) that corresponds to the number found in the schematics (C001 in a bill of material is equivalent to C1 on the schematic) or 2) gives added information or further explanation (i.e., “Used for 208V operation only,” or “Used for HT 10LS only,” etc.).

NOTE: Inside the individual tables some standard conventions are used:

- A # symbol in front of a component such as #C001 under the REF. SYMBOLS/EXPLANATIONS column means that this item is used on or with C001 and is not the actual part number for C001.
- In the ten digit part numbers, if the last three numbers are 000 the item is a part that has been purchased and has not manufactured or modified. If the last three numbers are other than 000 the item is either manufactured or is purchased from a vendor and modified for use in the Harris Broadcast product.
- The first three digits of the ten digit part number tell which family the part number belongs to - for example, all electrolytic (can) capacitors will be in the same family (524 xxxx 000). If an electrolytic (can) capacitor is found to have a 9xx xxxx xxx part number (a number outside of the normal family of numbers), it has probably been modified in some manner at the factory and will therefore show up farther down into the individual parts list (because each table is normally sorted in ascending order). Most Harris Broadcast made or modified assemblies will have 9xx xxxx xxx numbers associated with them.

The term “SEE HIGHER LEVEL BILL” in the description column implies that the reference designated part number will show up in a bill that is higher in the tree structure. This is often the case for components that may be frequency determinant or voltage determinant and are called out in a higher level bill structure that is more customer dependent than the bill at a lower level.

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7.1 Replaceable Parts List

Table 7-1 MAXIVA ULX 16PA FORMAT TRANSMITTER - - - - - - - - - - - - 9950228001G (AN) 7-3
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Table 7-5 KIT, ULX/VLX SYSTEM WIRING - - - - - - - - - - - - - - - - - - 943 5276 184 (E) 7-5
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For table above and in tables that follow in this section the (X) or (XX) after the table title part number is the revision level of that bill of material and is for reference only.

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Table 7-1 MAXIVA ULX 16PA FORMAT TRANSMITTER - 9950228001G (AN)

Part Number	Description	Qty UM	Reference Designators
472 1888 000	XFMR, 480V/208V, 3 PH, 112.5 KVA, K13 RATED	0 EA	
556 0179 150	ATTEN, SMA, 15DB, 2W, 50 OHM	0 EA	
774 0156 080	KIT PLUMB U/VLX 1PA 1-1/2 HOSE	0 EA	
774 0156 081	KIT, PLUMBING ULX/VLX 1PA PIPE	0 EA	
774 0156 086	KIT, PLUMBING, FILTER COOLING (ULX/VLX)	0 EA	
774 0156 115	KIT, TRANSFER PUMP 115V	0 EA	
774 0156 220	KIT, TRANSFER PUMP 220V	0 EA	
880 0228 001	TEST PROCEDURE FOR ULX TRANSMITTER.	0 DWG	
917 2416 969	KIT, CHANNEL COMBINED ULX SAMPLES	0 EA	
943 5276 184	KIT, ULX/VLX SYSTEM WIRING	0 EA	
952 9253 017	CABLE JUMPER PLUG 208-240V	0 EA	
952 9253 018	CABLE JUMPER PLUG 380-415V	0 EA	
952 9253 019	CABLE EXC A ASI	0 EA	
952 9253 020	CABLE EXC B ASI	0 EA	
952 9253 021	CABLE EXC A RF EXTERNAL	0 EA	
952 9253 022	CABLE ECX B RF EXTERNAL	0 EA	
952 9253 058	CABLE, ANALOG EXCITER B I/O	0 EA	
971 0023 183	COUPLER, UHF 3-1/8 3 PORT, 48 48DB FOR; 48DB REF	0 EA	
971 0040 003	*ASSEMBLY, TRITON PA MODULE	0 EA	
971 0040 004	ASSEMBLY, MAXIVA ULX PA MODULE	18 EA	
971 0040 020	CUSTOMER I/O ASSEMBLY, DIGITAL	0 EA	A1
971 0040 033	DUAL CIRCUIT BREAKER ASSEMBLY, 208-240V	0 EA	
971 0040 037	DUAL CIRCUIT BREAKER ASSEMBLY, 380-415V	0 EA	
971 0040 059	ANALOG PKG 12 16PA	0 EA	
971 0040 075	KIT, CE DIGITAL MAXIVA ULX	0 EA	
971 0040 081	KIT, PA DIAGNOSTICS UNIT	0 EA	
971 0040 095	KIT, SINGLE EXCITER	0 EA	
981 0147 001	HEAT EXCHANGER, 50HE DUAL FAN	0 EA	
981 0147 002	HEAT EXCHANGER, 50HESCE, DUAL FAN SEVERE CORROSIVE ENVIRONMENT	0 EA	
981 0222 012	MAXIVA ULX, PA MODULE TEST FIXTURE	0 EA	
981 0418 001	MAXIVA ULX 16PA BASIC TRANSMITTER	1 EA	
988 2628 301	DP, MAXIVA ULX SERIES	1 EA	
990 0160 001	SPK, ULX XTR 208/240V RECOMMEND SPARE PARTS	0 EA	
990 0160 002	SPK, ULX PA MODULE REPAIR KIT	0 EA	
990 0160 003	SPK, ULX XTR 380/415V RECOMMEND SPARE PARTS	0 EA	
990 0160 004	SBK, ULX TCU PC KIT SPARE BOARDS	0 EA	
990 0160 014	SPK, ULX/VLX HI EFFICIENCY PUMP MODULE, HE II	0 EA	
990 0160 016	SPK, HEAT EXCHANGER HE20 AND HE50	0 EA	
992 9138 051	KIT, RF LINE 1PA CAB, (5-16) MAXIVA	0 EA	
992 9138 056	KIT, RF LINE 1PA CAB, (16) MAXIVA ANALOG	0 EA	
992 9139 090	KIT, INSTALL MATERIAL, MAXIVA 1 PA CAB	0 EA	
995 0063 001	!FORMAT EXCITER APEX M2X DVBT	0 EA	A2 A3
995 0063 002	!FORMAT EXCITER APEX M2X ISDBT	0 EA	A2 A3
995 0063 004	!FORMAT EXCITER APEX M2X ATSC	0 EA	A2 A3
995 0063 005	!FORMAT EXCITER APEX M2X ATV	0 EA	A2 A3
995 0063 009	!FORMAT EXCITER APEX M2X DVBT2	0 EA	A2 A3
995 0333 004	ASSY, PUMP MODULE, HE II 50/60HZ, 208-240V/308-415V	0 EA	
484 0606 000	FILTER, LOWPASS, 20KW UHF BAND A	0 EA	
484 0607 000	FILTER, LOWPASS, 20KW UHF BAND B	0 EA	
484 0608 000	FILTER, LOWPASS, 20KW UHF BAND C	0 EA	
484 0609 000	FILTER, LOWPASS, 20KW UHF BAND D	0 EA	
484 0781 000	FILTER, LP UHF 4-1/16 BAND A	0 EA	
484 0782 000	FILTER, LP UHF 4-1/16 BAND B	0 EA	
484 0783 000	FILTER, LP UHF 4-1/16 BAND C	0 EA	
484 0784 000	FILTER, LP UHF 4-1/16 BAND D	0 EA	
981 0202 001	FILTER, LOW PASS DTV IN-SYSTEM	0 EA	

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981 0202 002	FILTER, LOW PASS DTV IN-SYSTEM	0 EA
981 0202 003	FILTER, LOW PASS DTV IN-SYSTEM	0 EA
981 0202 004	FILTER, LOW PASS DTV IN-SYSTEM	0 EA
483 0170 000	*FILTER, MASK UHF 6-POLE 15KW	0 EA
483 0180 000	*FILTER, MASK UHF 8-POLE 15KW	0 EA
483 0190 000	*FILTER, MASK UHF 6-POLE 15KW	0 EA
483 0200 000	*FILTER, MASK UHF 8-POLE 15KW	0 EA
483 0210 000	*FILTER, MASK UHF 6-POLE 15KW	0 EA
483 0220 000	*FILTER, MASK UHF 8-POLE 15KW	0 EA
483 0230 000	*FILTER, MASK UHF 6-POLE 10KW	0 EA
483 0290 000	*FILTER, MASK UHF 8-POLE 10KW	0 EA
484 1025 000	FILTER, BANDPASS UHF ANALOG, 30KW	0 EA

Table 7-2 KIT PLUMB U/VLX 1PA 1-1/2 HOSE - 774 0156 080 (H)

Part Number	Description	Qty UM	Reference Designators
624 0004 200	PIPE CLAMP, 2.00 DIA NON-INSUL	4 EA	
774 0156 082	KIT, PLUMB HDWE ULX/VLX 1PA	1 EA	
774 0156 084	KIT, PLUMB U/VLX 1PA HOSE FITTINGS	1 EA	
843 5607 072	LAYOUT, TYPICAL PLUMBING, HE PUMP MODULE	0 DWG	
021 7510 003	HOSE, RUBBER 1.500" ID	100 FT	
359 1573 000	HOSE BARB, 1.50H X 1.50MPT	6 EA	
943 5585 257	ASSY, MANIFOLD SUPPLY/RETURN MAXIVA	1 EA	
358 0473 000	HOSE CLAMP, SST, SAE-28	6 EA	
971 0040 092	ASSY, SIGHT FLOW INDICATOR	1 EA	
358 2179 000	ROD, THREADED 3/8-16 X 10FT LG	12 EA	
358 3945 000	CABLE TRAY, WIRE 6W X 2.00H X 120L	1 EA	
358 3946 000	TRAPESE CLIP, CABLE TRAY	24 EA	
358 3481 100	CHANNEL, STRUT 1-5/8 X 1-5/8 10FT	1 EA	

Table 7-3 KIT, PLUMBING ULX/VLX 1PA PIPE - 774 0156 081 (F)

Part Number	Description	Qty UM	Reference Designators
063 1030 021	* PIPE SEALANT "PST" LOCTITE 565	1 EA	
086 0004 038	SOLDER, SILVER SIZE 0.062	1 LB	
086 0004 047	SOLDER, SILVER 4% 0.125 DIA	1 LB	
086 0026 000	*SOLDER FLUX, PASTE, 'STAY-CLEAN'	1 EA	
358 2179 000	ROD, THREADED 3/8-16 X 10FT LG	12 EA	
774 0156 082	KIT, PLUMB HDWE ULX/VLX 1PA	1 EA	
774 0156 083	KIT, PLUMB ULX/VLX 1PA PIPE (LESS HDWE)	1 EA	
843 5607 072	LAYOUT, TYPICAL PLUMBING, HE PUMP MODULE	0 DWG	
939 8106 939	CU TUBING 1.625 OD (1.5 NOM) 10 FT LENGTH	10 EA	
943 5585 257	ASSY, MANIFOLD SUPPLY/RETURN MAXIVA	1 EA	
971 0040 092	ASSY, SIGHT FLOW INDICATOR	1 EA	
358 3481 100	CHANNEL, STRUT 1-5/8 X 1-5/8 10FT	1 EA	
359 1897 000	PIPE HANGER, J-TYPE 1.50" INS	6 EA	

Table 7-4 KIT, CHANNEL COMBINED ULX SAMPLES - 917 2416 969 (C)

Part Number	Description	Qty UM	Reference Designators
556 0141 000	*ATTEN, SMA, 5DB, 0.5W, 50 OHM	1 EA	
620 3175 000	ADAPTER, SMA-JACK TO SMA-JACK	1 EA	
700 1422 019	LOAD, 0.5W, SMA PLUG, 50 OHM	1 EA	
817 2416 969	INSTR, CHANNEL COMBINED ULX SAMPLES	0 DWG	
843 5601 993	DIAG, ULX CHANNEL COMBINED RF SAMPLES	0 DWG	
917 2417 339	CBL, COAX, #401 POST COMBINER SAMPLE	1 EA	

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Table 7-5 KIT, ULX/VLX SYSTEM WIRING - 943 5276 184 (E)

Part Number	Description	Qty UM	Reference Designators
003 4010 082	CU, STRAP 0.020 X 2" X 50	1 EA	
250 0443 000	CABLE, 12C 20AWG STRD	50 FT	
253 0059 000	CABLE, 2C 22AWG AUDIO	50 FT	
464 0381 000	TOOL, ACTUATION, WAGO 2.5MM	1 EA	
618 0511 100	*COAX CABLE, RG-223/U, 100 FT REEL	1 RL	
620 0818 000	PLUG, BNC STRAIGHT CABLE	4 EA	
620 2174 000	'N' PLUG CRIMP ST	4 EA	
620 2938 000	PLUG, SMA RG-55 STRAIGHT	8 EA	

Table 7-6 *ASSEMBLY, TRITON PA MODULE - 971 0040 003 (C)

Part Number	Description	Qty UM	Reference Designators
612 1350 000	JACK, SMB STRAIGHT PCB	1 EA	J2A17
843 5601 012	WIRING DIAGRAM, PA MODULE	0 DWG	
943 5601 427	PANEL, FRONT, PA MODULE WITH SAMPLE PORT	1 EA	
943 5601 638	COLDPLATE ASSY, ULX PA MODULE W/SAMPLE PORT	1 EA	
952 9253 015	CABLE COAX W5	1 EA	#J2A17
9710040004WI	WI, ULX PA MODULE	0 DWG	
971 0040 100	ASSEMBLY, PA MODULE, BASIC, TRITON	1 EA	

Table 7-7 ASSEMBLY, PA MODULE, BASIC, TRITON - 971 0040 100 (N)

Part Number	Description	Qty UM	Reference Designators
007 4030 001	FINGERSTOCK, 97-0520-02	0.143 EA	
063 0001 060	*COMPOUND #4	0 EA	
088 0001 089	TAPE, ELEC 1.75 IN W	0 RL	
252 0465 000	WIRE RIBBON SILVER 0.005 X 0.050	0.5 FT	
302 0012 000	SCR, 2-56 X 1/4	2 EA	#A18J3
302 0803 025	SEMS, PHMS M3-0.5 X 25 SST	24. EA	4#A3 4#A4 4#A5 4#A6 4#A7 4#A8 4#A9 4#A10
302 0952 000	<*>SCREW, SHMS M4-0.7 X 12 SST	16 EA	#A13 A14 A15 A16
310 0003 000	WASHER, FLAT #4 SST (ANSI NARROW)	4 EA	A1
311 0011 030	WASHER, FLAT M3 SST (DIN125)	5 EA	
315 0021 030	LOCKWASHER, SPLIT M3 SST (DIN127)	21 EA	
315 0021 040	LOCKWASHER, SPLIT M4 SST (DIN127)	16 EA	#A13 A14 A15 A16
325 0020 000	LOCKNUT, KEP HEX M3-0.5 (ZINC)	4 EA	A1
336 1330 000	STDOFF-M/F-4.5MM HEX-M3X0.5X5L	9 EA	
336 1390 000	RETAINING RING, 1.062" SHAFT (27MM)	1 EA	
350 0046 000	RIVET 0.156 DIA, DOME HEAD, OPEN END	8 EA	
359 1591 000	FLUID COUPLER, FEMALE SSR605	2 EA	
408 0338 000	GASKET, EMI, 0.13 TALL X 0.19	1.30 EA	
410 0627 000	STDOFF, M3 X 0.5 8MM	12 EA	
411 0126 000	THERMAL INTERFACE, AC-DC CONV	8 EA	
414 0348 000	CORE, EMI SUPPRESSION, 0.5" ID	1 EA	
414 0394 000	CORE, SNAP ON HIGH FREQ 0.2" ID	1 EA	
690 0021 000	*TORQUE SEAL, ORANGE	0 EA	4#R8 4#R27
843 5601 012	WIRING DIAGRAM, PA MODULE	0 DWG	
9010222011G	PWA, AC/DC CONVERTER INTERFACE	8 EA	A3 A4 A5 A6 A7 A8 A9 A10
9010222021G	PWA, AC DISTRIBUTION	1 EA	A2
9010222041G	PWA, I/O CONNECTOR BOARD	1 EA	A1
9010222051G	PWA, PA MONITOR BOARD	1 EA	A18
9010222061G	PWA, SIGNAL DISTRIBUTION BOARD	1 EA	A12
9010222071G	PWA, 4-WAY SPLITTER & SPREADER	1 EA	A11
9010222081G	PWA, PA PALLET	4 EA	A13 A14 A15 A16
9010222091G	PWA, 4-WAY COMBINER & SPREADER	1 EA	A17
922 1300 019	CABLE, RF INPUT	1 EA	
943 5601 009	RING, TEFLON, 7/8" RF RECPTACLE	1 EA	
943 5601 011	INSULATION, AC DISTRIBUTION PWA	1 EA	

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943 5601 046	FENCE, PALLET SHIELD	3 EA	
943 5601 047	FENCE, RF DIVIDER	1 EA	
943 5601 048	COVER, PA MODULE	1 EA	
943 5601 061	WASHER, SHOULDER	4 EA	
943 5601 101	FENCE, PALLET SHIELD	1 EA	
943 5601 125	PANEL, SIDE WALL, RIGHT	1 EA	
943 5601 126	PANEL, SIDE WALL, LEFT	1 EA	
943 5601 128	PANEL, FRONT WALL	1 EA	
943 5601 130	COVER, SOLDER	1 EA	
943 5601 137	SHIELD, COMBINER TRITON PA MODULE	1 EA	
943 5601 230	BODY, 7/8" RF PLUG	1 EA	
943 5601 388	MODULE 7/8 CONDUCTOR, CENTER	1 EA	
943 5601 392	INSULATION, I/O PWA	1 EA	A1
943 5601 430	PANEL, BACK WALL	1 EA	
952 9253 001	CABLE KIT MODULE	1 EA	
952 9253 006	CABLE RIBBON W2/W4	2 EA	

Table 7-8 PWA, AC/DC CONVERTER INTERFACE - 9010222011G (T)

Part Number	Description	Qty UM	Reference Designators
358 2997 000	END PLATE, GREY (236)	1 EA	1/TB1
384 0357 000	DIODE, RECT 1N4004 (DO-41)	1 EA	CR1
384 0961 000	LED, YEL T1 VERT	1 EA	DS1
398 0777 001	FUSE 8A 250V FAST 5MM X 20MM	1 EA	F1
402 0198 000	FUSECLIP, 5MM/2AG FUSE, PCB MT	2 EA	2/XF1
409 0089 000	SPACER, SWAGE 0.125''	4 EA	MTG1 MTG2 MTG3 MTG4
502 0269 000	CAP, 470NF 450V 2W 10%	4 EA	C2 C3 C10 C11
508 0636 000	CAP, 1UF 20% 275VAC 630VDC	1 EA	C1
516 0419 000	CAP DISC 0.05UF 500V -20/+80%	1 EA	C12
516 0516 000	CAP 1UF 100V 20%	2 EA	C8 C9
522 0837 000	CAP, 330UF 20% 450V	2 EA	C4 C6
522 0857 000	CAP, 120UF 100V 20%	2 EA	C5 C7
540 1643 000	RESISTOR, 470K 1W 5%	1 EA	R11
542 1672 000	RES, WW 100 OHM 5W 5% RADIAL	1 EA	R12
548 0502 000	*RES 9.09K OHM 1/2W 0.1% 50PPM	1 EA	R4
548 2400 030	RES 2 OHM 1/2W 1%	1 EA	R3
548 2400 379	RES 6.49K OHM 1/2W 1%	1 EA	R7
548 2400 401	RES 10K OHM 1/2W 1%	1 EA	R1
548 2400 601	RES 1MEG OHM 1/2W 1%	1 EA	R5
548 2512 000	RES 40K 0.1% 10PPM FILM	1 EA	R8
550 0913 000	POT 5K OHM 1/2W 10%	1 EA	R9
610 0877 000	HDR, 2C VERT 1ROW UNSHR	1 EA	JP1
612 1184 000	JUMPER SHUNT, 2C, 0.1'' PITCH	1 EA	1/JP1
612 2480 000	HEADER, 10C 11.5A 0.200" CENTERS	1 EA	J1
614 0790 000	TERM BLK, PCB, 1-POLE, GREY (236)	1 EA	TB1
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
736 0555 000	PSU (SW), 48VDC 504W	1 EA	U1
801 0222 010	SPEC, AC/DC CONVERTER INTERFACE	0 DWG	
801 0222 011	SCH, AC/DC CONVERTER INTERFACE	0 DWG	
8010222013G	PWB, AC/DC CONVERTER INTERFACE	1 EA	

Table 7-9 PWA, AC DISTRIBUTION - 9010222021G (G)

Part Number	Description	Qty UM	Reference Designators
303 4103 010	SCREW, PHMS M3-0.5 X10 (SST)	1 EA	
307 0001 030	NUT, STD HEX M3-0.5 (SST)	1 EA	
311 0011 030	WASHER, FLAT M3 SST (DIN125)	1 EA	
315 0021 030	LOCKWASHER, SPLIT M3 SST (DIN127)	1 EA	
382 1863 000	REG, 2.5-50V 100KHZ OUT	1 EA	U1
384 0961 000	LED, YEL T1 VERT	1 EA	DS1

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384 1157 000	RECT FAST, 8ETH06 (TO220)	1 EA	CR2
386 1543 000	DIODE, TVS (BIDIR) 20KPA180CA	6 EA	CR1 CR3 CR4 CR5 CR6 CR7
404 0910 001	HEATSINK,TO-220 1.5"HT	1 EA	HS1
416 0006 000	COMMON MODE IND, 2.5MH 12.5A	6 EA	L1 L2 L3 L4 L5 L6
494 0579 000	IND, 120UH 2A 10% RADIAL	1 EA	L7
508 0636 000	CAP, 1UF 20% 275VAC 630VDC	9 EA	C2 C3 C4 C9 C10 C11 C15 C16 C17
508 0696 001	CAP, 0.01UF 20% URAC=300V	3 EA	C8 C12 C13
516 0516 000	CAP 1UF 100V 20%	2 EA	C1 C7
516 0530 000	CAP 0.010UF 10% 100V X7R	1 EA	C14
522 0857 000	CAP, 120UF 100V 20%	1 EA	C5
522 0858 000	CAP 470UF 16V 20% 8MM 105C LOW-Z	1 EA	C6
542 1846 000	RES, WW 10 OHM 10W 5% RADIAL	3 EA	R6 R7 R8
548 2400 318	RES 1.5K OHM 1/2W 1%	1 EA	R13
548 2400 339	RES 2.49K OHM 1/2W 1%	2 EA	R10 R12
548 2400 405	RES 11K OHM 1/2W 1%	1 EA	R11
560 0049 000	*MOV, 275WVAC, 75J, 14MM DISC	6 EA	RV1 RV2 RV3 RV4 RV5 RV6
574 0543 000	RELAY, SPDT 12VDC 20A/10A	3 EA	K1 K2 K3
610 1519 000	<*>HDR, 14C 2ROW VERTICAL (SYS 50)	1 EA	J9
612 2480 001	HEADER, 10C 13A 0.200" CENTERS	8 EA	J1 J2 J3 J4 J5 J6 J7 J8
612 2495 000	HDR, 2C 7.5MM PITCH SABRE, VERT	3 EA	TB1 TB2 TB3
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
740 1353 000	POLYSWITCH, PTC 40A 72V	1 EA	R3
801 0222 020	SPEC, AC DISTRIBUTION BOARD	0 DWG	
801 0222 021	SCH, AC DISTRIBUTION	0 DWG	
8010222023G	PWB, AC DISTRIBUTION	1 EA	

Table 7-10 PWA, I/O CONNECTOR BOARD - 9010222041G (C--)

Part Number	Description	Qty UM	Reference Designators
610 1066 000	LUG QC250 MALE PCB VERTICAL	1 EA	E1
610 1287 001	*HDR (RIBBON), 20C 2ROW VERTICAL	1 EA	J2
611 0116 000	HDR, VERT BLINDMATE PRE-MATE	1 EA	J1
612 2495 000	HDR, 2C 7.5MM PITCH SABRE, VERT	3 EA	TB1 TB2 TB3
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
801 0222 041	SCH, I/O CONNECTOR BOARD	0 DWG	
9010222042G	PWA SMT, I/O CONNECTOR BOARD	1 EA	

Table 7-11 PWA, PA PALLET - 9010222081G (K1)

Part Number	Description	Qty UM	Reference Designators
000 0000 010	BOM NOTE:	0 DWG	
055 0100 005	*THERMAL COMPOUND, 8OZ JAR	0 EA	
302 0803 001	<*>SEMS, SHMS M2.5-0.45 X 8 SST	30 EA	
544 1706 002	TERMINATION 50R 250W 5%	1 EA	R2
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
700 1411 000	TERMINATION 50 OHM 10W 5%	1 EA	R32
801 0222 081	SCH, PA PALLET	0 DWG	
8010222183G	UHF 3DB HYBRID	2 EA	HY1 HY2
9010222081WI	WI, UAX/ULX PA PALLET	0 DWG	
9010222082G	PWA SMT, PA PALLET	1 EA	
943 5601 015	HEAT SPREADER, PALLET	1 EA	
943 5601 022	DC JUMPER	2 EA	JP1 JP2
943 5601 041	ASSEMBLY, MOSFET	2 EA	Q1 Q2
943 5601 117	INDUCTOR	2 EA	L1 L2

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Table 7-12 ASSEMBLY, MAXIVA ULX PA MODULE - 971 0040 004 (R)

Part Number	Description	Qty UM	Reference Designators
088 0012 000	TAPE 3M #483 POLYETHYLENE 2''W	0 RL	
843 5601 012	WIRING DIAGRAM, PA MODULE	0 DWG	
880 0040 100	TP, AUTOMATED TEST FOR FULL ULX PA	0 DWG	
943 5601 122	COLDPLATE ASSY, ULX PA MODULE	1 EA	
943 5601 129	PANEL, FRONT, PA MODULE	1 EA	
9710040004WI	WI, ULX PA MODULE	0 DWG	
971 0040 100	ASSEMBLY, PA MODULE, BASIC, TRITON	1 EA	

Table 7-13 CUSTOMER I/O ASSEMBLY, DIGITAL - 971 0040 020 (E)

Part Number	Description	Qty UM	Reference Designators
168-806-000	CONNECTOR RJ45 8-POLE SCREENED	1 EA	J23
620 3014 000	ADAPTER, SMA JACK-JACK BULKHEAD	2 EA	UNIT 2J6 UNIT 3J6
943 5601 171	PLATE, SILKSCREEN, DIGITAL	1 EA	

Table 7-14 DUAL CIRCUIT BREAKER ASSEMBLY, 208-240V - 971 0040 033 (U)

Part Number	Description	Qty UM	Reference Designators
026 6010 002	GROMMET STRIP, 0.090	4 FT	
358 3637 000	PLATE, END STOP, DIN RAIL MTG	4 EA	
606 1136 080	CKT BRKR 8 AMPS 2P 480VAC	6 EA	CB19 CB20 CB21 CB22 CB25 CB26
606 1290 125	CKT BRKR 125 AMPS 4P 480VAC	2 EA	CB23 CB24
614 0810 000	JUMPER, ADJACENT 2-POLE (283:283) 12MM	4 EA	
614 0930 000	TERM BLK, THRU, 2-POLE GREY (283) 12MM	14 EA	
614 0954 000	TERM BLK, THRU, 2-POLE GREY (285) 16MM	8 EA	
614 0960 000	JUMPER, ADJACENT 2-POLE (285:285) 16MM	10 EA	
917 2567 010	DIN RAIL, CUT LENGTH 360MM	1 EA	
917 2567 212	DIN RAIL, CUT LENGTH 450MM	1 EA	
943 5576 367	STANDOFF, MALE-FEMALE, M4	4 EA	
943 5601 150	CHASSIS, MAIN BREAKER	1 EA	
943 5601 151	PANEL, MAIN BREAKER W/2 MAINS	1 EA	
943 5601 153	ASSY, MAIN BREAKER BRACKET	1 EA	
943 5601 154	ASSY, MAIN BREAKER REAR ACCESS PANEL	1 EA	
971 0040 009	MOV, 3PH 208V DELTA MAXIVA ULX	2 EA	A15A1 A15A2
9710040033WI	WI, DUAL CIRCUIT BREAKER ASSY	0 DWG	

Table 7-15 MOV, 3PH 208V DELTA MAXIVA ULX - 971 0040 009 (C)

Part Number	Description	Qty UM	Reference Designators
560 0019 000	MOV, 320WVAC, 460J, 40MM DISC	4 EA	RV1 RV2 RV3 RV4
9010222361GT	PWA, MOV/AC SAMPLE, TESTED	1 EA	
917 2550 517	CABLES, JUMPERS 3PH DELTA	1 EA	

Table 7-16 PWA, MOV/AC SAMPLE, TESTED - 9010222361GT (A)

Part Number	Description	Qty UM	Reference Designators
9010222361G	PWA, MOV/AC SAMPLE	1 EA	

Table 7-17 CABLES, JUMPERS 3PH DELTA - 917 2550 517 (B)

Part Number	Description	Qty UM	Reference Designators
252 0552 010	WIRE, UL, 10AWG 600V GRAY	2 FT	
354 0754 000	LUG QC FEM 250 12-10AWG YEL	8 EA	
817 2550 517	CADS 3PH MOV PKG (DELTA)	0 DWG	

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Table 7-18 DUAL CIRCUIT BREAKER ASSEMBLY, 380-415V - 971 0040 037 (T)

Part Number	Description	Qty UM	Reference Designators
026 6010 002	GROMMET STRIP, 0.090	4 FT	
358 3637 000	PLATE, END STOP, DIN RAIL MTG	4 EA	
606 1136 080	CKT BRKR 8 AMPS 2P 480VAC	6 EA	CB19 CB20 CB21 CB22 CB25 CB26
606 1290 080	CKT BRKR 80 AMPS 4P 480VAC	2 EA	CB23 CB24
614 0810 000	JUMPER, ADJACENT 2-POLE (283:283) 12MM	6 EA	
614 0930 000	TERM BLK, THRU, 2-POLE GREY (283) 12MM	14 EA	
614 0954 000	TERM BLK, THRU, 2-POLE GREY (285) 16MM	8 EA	
614 0960 000	JUMPER, ADJACENT 2-POLE (285:285) 16MM	8 EA	
917 2567 010	DIN RAIL, CUT LENGTH 360MM	1 EA	
917 2567 212	DIN RAIL, CUT LENGTH 450MM	1 EA	
943 5576 367	STANDOFF, MALE-FEMALE, M4	4 EA	
943 5601 150	CHASSIS, MAIN BREAKER	1 EA	
943 5601 151	PANEL, MAIN BREAKER W/2 MAINS	1 EA	
943 5601 153	ASSY, MAIN BREAKER BRACKET	1 EA	
943 5601 154	ASSY, MAIN BREAKER REAR ACCESS PANEL	1 EA	
971 0040 010	MOV, 3PH 400V WYE MAXIVA ULX	2 EA	A15A1 A15A2
9710040033WI	WI, DUAL CIRCUIT BREAKER ASSY	0 DWG	

Table 7-19 ANALOG PKG 12 16PA - 971 0040 059 (C)

Part Number	Description	Qty UM	Reference Designators
952 9253 057	CABLE ,ANALOG EXCITER A I/O	1 EA	
952 9253 063	CABLE ANALOG RF	1 EA	
952 9253 064	CABLE COAX, 86 87 88 89	4 EA	
952 9253 065	CABLE RIBBON W4	1 EA	
971 0040 022	CUSTOMER I/O ASSEMBLY, ANALOG	1 EA	

Table 7-20 KIT, CE DIGITAL MAXIVA ULX - 971 0040 075 (C)

Part Number	Description	Qty UM	Reference Designators
302 0972 000	SCREW SKT HD CAP M5 X 18	4 EA	
344 0248 000	SCREW, #8 X 3/4L SHEET METAL	12 EA	
358 0498 000	*HOSE CLAMP, SST, SAE-48	22 EA	
448 1082 000	GASKET, EMI/RFI SHIELDING,	27.15 FT	
448 1383 000	LATCH, FLUSH MOUNT, BLACK	2 EA	
448 1399 000	HINGE, METAL LIFT-OFF	2 EA	
943 5601 553	WINDOW, CE DOOR	1 EA	
943 5601 555	SHIELD, CE DOOR	1 EA	
943 5601 556	BRKT, CE DOOR	2 EA	
943 5601 557	FOAM SHIELD, CE DOOR	2 EA	
943 5601 558	FOAM SHIELD, CE DOOR	1 EA	
943 5601 559	FOAM SHIELD, CE DOOR	2 EA	
943 5601 560	FOAM SHIELD, CE DOOR	1 EA	
943 5601 632	TRITON EXHAUST HONYCOMB BRACKET	1 EA	
943 5601 633	TRION EXHAUST HONYCOMB	1 EA	
943 5601 678	PANEL ,DOOR, CE	1 EA	
943 5601 679	PANEL, SIDE, CE	2 EA	
943 5601 957	DOOR, FRONT	1 EA	

Table 7-21 KIT, PA DIAGNOSTICS UNIT - 971 0040 081 (A)

Part Number	Description	Qty UM	Reference Designators
256 0166 015	CABLE ASSY, USB-A/B, 1.5M	1 EA	
256 0346 000	CABLE, 50C 0.050" PLUG, 3M	1 EA	
971 0040 080	UNIT, PA DIAGNOSTICS	1 EA	
988 2765 001	DOC PKG, PA DIAGNOSTICS UNIT	1 EA	

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Table 7-22 HEAT EXCHANGER, 50HE DUAL FAN - 981 0147 001 (G3)

Part Number	Description	Qty UM	Reference Designators
303 6106 016	SCREW, HEX CAP M6-1 X 16	8 EA	
310 0009 000	WASHER, FLAT 1/4 (M6) SST (ANSI REGULAR)	8 EA	
315 0021 060	LOCKWASHER, SPLIT M6 SST (DIN127)	8 EA	
430 0397 000	FAN, 3 PHASE 230/400V 60 HZ	2 EA	
646 0665 000	LABEL, INSPECTION	1 EA	
708 0055 000	50KW FLUID COOLER COIL	1 EA	
843 5607 717	OUTLINE DRAWING, 50KW HEAT EXCHANGER	0 DWG	
843 5607 719	SKID HEAT EXCHANGERS	0 DWG	
943 5607 720	BRACKET, SHIPPING, FOR HEAT EXCHANGERS	4 EA	
971 5607 013	KIT, AC DISCONNECT	1 EA	
9810147001WI	WI, HEAT EXCHANGER, 50KW DUAL FAN	0 DWG	
988 2852 001	DP, HE HEAT EXCHANGER	1 EA	
990 0160 016	SPK, HEAT EXCHANGER HE20 AND HE50	0 EA	
943 5607 583	END CAP, 50KW HEAT EXCHANGER	4 EA	
943 5607 582	SIDE PANEL, 50KW HEAT EXCHANGER	2 EA	
943 5607 584	COVER, RETURN END, 50KW HEAT EXCHANGER	1 EA	
943 5607 585	COVER, MANIFOLD, 50KW HEAT EXCHANGER	1 EA	
943 5607 579	LEG, HEAT EXCHANGER	4 EA	
350 0105 000	RIVET 0.188 DIA, DOME HEAD, CLOSED END	44 EA	
303 6108 018	SCR, HEX CAP, M8-1.25 X 18 (SST)	8 EA	
311 0012 080	WASHER, FLAT M8 SST (DIN125)	8 EA	
315 0021 080	LOCKWASHER, SPLIT M8 SST (DIN127)	8 EA	

Table 7-23 HEAT EXCHANGER, 50HESCE, DUAL FAN SEVERE CRRSV ENVRO - 981 0147 002 (F1)

Part Number	Description	Qty UM	Reference Designators
303 6106 016	SCREW, HEX CAP M6-1 X 16	8 EA	
310 0009 000	WASHER, FLAT 1/4 (M6) SST (ANSI REGULAR)	8 EA	
315 0021 060	LOCKWASHER, SPLIT M6 SST (DIN127)	8 EA	
430 0397 000	FAN, 3 PHASE 230/400V 60 HZ	2 EA	
646 0665 000	LABEL, INSPECTION	1 EA	
708 0055 001	50KW HEAT EXCHANGER COIL	1 EA	
843 5607 717	OUTLINE DRAWING, 50KW HEAT EXCHANGER	0 DWG	
843 5607 719	SKID HEAT EXCHANGERS	0 DWG	
943 5607 720	BRACKET, SHIPPING, FOR HEAT EXCHANGERS	4 EA	
971 5607 013	KIT, AC DISCONNECT	1 EA	
9810147001WI	WI, HEAT EXCHANGER, 50KW DUAL FAN	0 DWG	
988 2852 001	DP, HE HEAT EXCHANGER	1 EA	
943 5607 583	END CAP, 50KW HEAT EXCHANGER	4 EA	
943 5607 582	SIDE PANEL, 50KW HEAT EXCHANGER	2 EA	
943 5607 584	COVER, RETURN END, 50KW HEAT EXCHANGER	1 EA	
943 5607 585	COVER, MANIFOLD, 50KW HEAT EXCHANGER	1 EA	
943 5607 579	LEG, HEAT EXCHANGER	4 EA	
350 0105 000	RIVET 0.188 DIA, DOME HEAD, CLOSED END	44 EA	
303 6108 018	SCR, HEX CAP, M8-1.25 X 18 (SST)	8 EA	
311 0012 080	WASHER, FLAT M8 SST (DIN125)	8 EA	
315 0021 080	LOCKWASHER, SPLIT M8 SST (DIN127)	8 EA	

Table 7-24 MAXIVA ULX, PA MODULE TEST FIXTURE - 981 0222 012 (P)

Part Number	Description	Qty UM	Reference Designators
021 7510 002	HOSE, 1/2'' ID, BLUE	16 FT	
055 0284 000	CONNECTOR, CABLE CLAMP 1/2 IN	3 EA	
167-702-010	JUMPER CABLE LCF1250 7/16M-7/16M A 1 0M SPIN	1 EA	
210-715-000	CONNECTOR R.F. 7/16 50R PANEL F-F SPIN	1 EA	
250 0506 000	CABLE, 4C 12AWG TYPE S0	20 FT	
354 0754 000	LUG QC FEM 250 12-10AWG YEL	15 EA	

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354 0763 001	*LUG QC FEMALE 187 12-10AWG YEL	15 EA
358 1314 000	*HOSE CLAMP, SST, SAE-10	4 EA
358 3025 000	HOSE BARB, 0.50H X 0.50MPT	2 EA
359 1875 000	FLUID COUPLER, MALE SSR601	2 EA
432 0573 000	COOLING SYSTEM, LYTRON MCS	1 EA
610 1296 000	PLUG, IEC C-14 FOR 14AWG	1 EA
620 2605 000	CONN, AIC 7/8	1 EA
620 3254 000	DIR COUPLER, 1-5/8" UHF	1 EA
620 3318 000	ADAPTOR, 1-5/8" TO 7/16 MALE	1 EA
628 0017 000	REDUCER 7/8EIA:TO:7/16-JACK (CU)	1 EA
628 0020 000	RF ADAPTER, 7/8" 50 OHMS	1 EA
702 0002 000	LOAD, 2500 W, OIL FILLED	1 EA
843 5601 612	BLOCK DIAGRAM, AC DISTRIBUTION	1 DWG
943 5601 170	HOSE BARB, 12 PUSHLOCK	2 EA
943 5601 217	ADAPTER, RF, MALE, LARGE FLANGE	1 EA
943 5601 228	CONDUCTOR, CENTER, IPA ADAPTER	1 EA
943 5601 600	CHASSIS, MODULE TEST FIXTURE	1 EA
943 5601 601	BLOCK TRANSITION, TEST FIXTURE PA COLDPLATE	1 EA
943 5601 602	COVER, MODULE TEST FIXTURE	1 EA
943 5601 603	COVER, MTG TEST FIXTURE	4 EA
943 5601 606	GUIDE, MODULE TEST FIXTURE	2 EA
943 5601 640	CART, MODULE TEST FIXTURE	1 EA
952 9265 111	CABLE # INPUT	1 EA
952 9265 112	CABLE # GND	1 EA
971 0040 081	KIT, PA DIAGNOSTICS UNIT	1 EA
981 0222 016	LATCH ASSY, ULX PA MOD TEST FIXTURE	1 EA
981 0223 001	CONTROL UNIT, MAXIVA PA MODULE TEST FIXTURE	1 EA
981 0223 002	PA MODULE INTERFACE UNIT, MAXIVA PA MODULE TEST FIXTURE	1 EA
988 2764 001	DOC PKG, MAXIVA PA MODULE TEST SET	2 EA

Table 7-25 MAXIVA ULX 16PA BASIC TRANSMITTER - 981 0418 001 (AZ)

Part Number	Description	Qty UM	Reference Designators
021 7510 002	HOSE, 1/2'' ID, BLUE	15.5 FT	
021 7510 004	HOSE, GEN PURP EPDM 1.25ID RED	9.9 FT	
088 0020 015	TAPE, SCOTCH FOAM	1 RL	
300 2910 000	FINISH SCREW M5 X 16 BLK	58 EA	
335 0465 000	O-RING, EPDM, #016 5/8'' ID	16 EA	
336 1254 000	*HOSE CLAMP, (MINI) SST, SAE-6	6 EA	
336 1391 000	NUT, CAGE M5	58 EA	
357 0126 002	GUIDE RAIL, PLASTIC	36 EA	
358 0498 000	*HOSE CLAMP, SST, SAE-48	1 EA	
358 1318 000	HOSE CLAMP, (MINI) SST, SAE-4	6 EA	
358 1761 000	HOSE CLAMP, SST, SAE-40	1 EA	
358 3637 000	PLATE, END STOP, DIN RAIL MTG	2 EA	
358 4038 000	HOSE CLAMP, LINED, SST, SAE-28	8 EA	
359 1269 000	HOSE, 3/8'' ID, BLUE	3.76 ME	
359 1874 000	HOSE BARB, 1.25H X 1.00MPT	1 EA	
359 1875 000	FLUID COUPLER, MALE SSR601	36 EA	
410 0496 025	STANDOFF, HEX 25MM M4 M/F BRASS	16 EA	
430 0292 000	FAN GUARD, 6.14" DIA.	2 EA	
430 0684 000	FAN, 20-28 VDC, 24V NOMINAL	1 EA	A19B1
560 0121 021	POSISTOR 3.75 AMP 60VDC 29MM DISC	1 EA	A19CB1
570 0405 000	CNTOR 60AMP 3P 240V	4 EA	K1 K2 K3 K4
606 1139 200	CKT BRKR 20 AMPS 4P 480VAC	18 EA	CB1 CB2 CB3 CB4 CB5 CB6 CB7 CB8 CB9 CB10 CB11 CB12 CB13 CB14 CB15 CB16 CB17 CB18
610 1253 000	PLUG, MALE 4C 1ROW STRAIGHT	1 EA	
620 0498 000	FLANGE, CLAMP-ON 3-1/8EIA (BRASS)	3 EA	

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620 0499 000	COUPLING 3-1/8U (CU)	5 EA	
620 0544 000	*CONN, AIC 3-1/8	2 EA	
620 0581 000	COUPLING/AIC 3-1/8U (CU)	4 EA	
620 0918 000	CONN, BULLET 3-1/8	6 EA	
620 2275 000	EQ ELBOW/90 3-1/8U (CU)	5 EA	
620 3008 000	ADAPTER, SMA-JACK TO SMA-PLUG, RT ANGLE	1 EA	
620 3750 000	SPLITTER/COMBINER, 3-WAY	2 EA	SP1 SP2
646 1483 000	NAMEPLATE, HARRIS LOGO	1 EA	
646 1701 000	NAMEPLATE, MAXIVA	1 EA	
646 1773 000	LABEL, POWERSMART 2.0 X 0.35	1 EA	
700 1422 042	RF LOAD, 10KW, 3-1/8 WATER COOL	1 EA	
792 0247 000	HYBRID, 3.01DB 20KW	1 EA	A14
843 5601 001	WIRING DIAGRAM PA MAIN, ULX	0 DWG	
9010222101G	PWA, 4PA BACKPLANE BOARD	4 EA	A5 A6 A8 A9
917 2567 017	DIN RAIL, CUT LENGTH 612MM	1 EA	
943 5560 052	PANEL, FRONT BLANK 2U	1 EA	
943 5601 049	CABLE BACKPLANE AC	8 EA	
943 5601 088	OUTER CONDUCTOR, 3 1/8	2 EA	
943 5601 089	PLATE, HYBRID SUPPORT	1 EA	
943 5601 091	PLATE, MANIFOLD MTG	6 EA	
943 5601 097	MANIFOLD ASSY, 10 PORT	2 EA	
943 5601 145	BRACKET, SPLITTER MTG	2 EA	
943 5601 146	BRACKET, SPLITTER SUPPORT	1 EA	
943 5601 169	HOSE BARB, 38 PUSHLOCK	6 EA	
943 5601 170	HOSE BARB, 12 PUSHLOCK	6 EA	
943 5601 192	PLUG, 916	2 EA	
943 5601 218	PIN, GUIDE	18 EA	
943 5601 232	INNER CONDUCTOR, 1.315	2 EA	
943 5601 238	MANIFOLD ASSY, 8 PORT	2 EA	
943 5601 239	COVER, BACKPLANE BOARD	4 EA	
943 5601 391	PLATE, HYBRID	1 EA	
943 5601 397	INSULATOR, BACKPLANE	4 EA	
943 5601 445	PLATE, RF OUTPUT	1 EA	
943 5601 460	SUPPORT, COMBINER LOAD	1 EA	
943 5601 466	BRACE, COMBINER	2 EA	
943 5601 593	OUTER CONDUCTOR, 3 1/8	1 EA	
943 5601 594	INNER CONDUCTOR, 1.315	1 EA	
943 5601 620	LABEL, UNIT 1 FRONT	1 DWG	
943 5601 629	LABEL, 16 PA REAR	1 DWG	
943 5601 934	SLIDE ANGLE, UEP	4 EA	
943 5601 939	COAX BLOCK	16 EA	
952 9237 027	CABLE, CAN BUS DISTRIBUTION	1 EA	
952 9253 011	CABLE BRKR SLOT 5 - SLOT 8	1 EA	
952 9253 012	CABLE BRKR SLOT 1 - SLOT 4	1 EA	
952 9253 014	CABLE MODULE SPLITTER	16 EA	
952 9253 016	CABLE CONTROL	1 EA	
952 9253 025	CABLE RIBBON W9	1 EA	
952 9253 026	CABLE RIBBON W10	1 EA	
952 9253 027	CABLE RIBBON W13	1 EA	
952 9253 035	CABLE RIBBON W8	1 EA	
952 9253 036	CABLE AC INPUT (9 + PA'S)	1 EA	
952 9253 039	CABLE PKG SPLITTER HIGH POWER	1 EA	
952 9253 059	CABLE IPA1	1 EA	
952 9253 074	CABLE, FAN REAR DOOR	1 EA	
971 0023 183	COUPLER, UHF 3-1/8 3 PORT, 48 48DB FOR; 48DB REF	1 EA	DC1
971 0040 040	SPLITTER, 2-WAY, MAXIVA ULX	1 EA	SP7
971 0040 045	8-WAY SPLITTER, MAXIVA ULX	2 EA	SP5 SP6
971 0040 155	8-WAY COMBINER, MAXIVA ULX	2 EA	A12 A13
971 0053 416	ASSY, BUSBAR 4P 4-BRKR (16TAP)	3 EA	

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971 0053 420	ASSY, BUSBAR 4P 5-BRKR (20TAP)	1 EA	
981 0293 012	ASM, TCU, PPC, ULX SYSTEM-16PA,	1 EA	A4
981 0400 001	MAXIVA COMMON COMPONENTS	1 EA	

Table 7-26 SPK, ULX XTR 208/240V RECOMMEND SPARE PARTS - 990 0160 001 (J)

Part Number	Description	Qty UM	Reference Designators
335 0486 000	O-RING, #013 EPDM 7/16'' ID NOM	4 EA	
359 1591 000	FLUID COUPLER, FEMALE SSR605	1 EA	
359 1875 000	FLUID COUPLER, MALE SSR601	1 EA	
398 0489 000	FUSE, CART 5X20MM 2A SLOW	5 EA	
398 0496 000	FUSE, CART 5X20MM 4A SLOW	5 EA	
398 0586 000	*FUSE 12AMP 600V FAST (10X38)	5 EA	
398 0777 001	FUSE 8A 250V FAST 5MM X 20MM	5 EA	
448 0868 000	AIR FILTER 14 X 20 X .88	20 EA	
510 0794 000	CAP, MOTOR 2.5UF 230V	1 EA	
570 0405 000	CNTOR 60AMP 3P 240V	1 EA	
606 1136 080	CKT BRKR 8 AMPS 2P 480VAC	1 EA	
606 1139 200	CKT BRKR 20 AMPS 4P 480VAC	1 EA	
606 1290 125	CKT BRKR 125 AMPS 4P 480VAC	1 EA	
629 0093 000	SENSOR, LIQUID LEVEL, FLOAT	1 EA	
629 0181 000	METER, FLOW 1 IN, 8-60 GPM	1 EA	
943 5601 235	SENSOR, TEMP	1 EA	
943 5601 710	REPLACEMENT FAN AND CABLE	1 EA	
9710039008T	ASM, PS MODULE, TESTED	1 EA	
971 0040 009	MOV, 3PH 208V DELTA MAXIVA ULX	1 EA	

Table 7-27 SPK, ULX PA MODULE REPAIR KIT - 990 0160 002 (D)

Part Number	Description	Qty UM	Reference Designators
398 0777 001	FUSE 8A 250V FAST 5MM X 20MM	8 EA	
411 0126 000	THERMAL INTERFACE, AC-DC CONV	4 EA	
544 1703 000	RES, TERMINATION 500W 50 OHM	1 EA	
9010222011GT	PWA, AC/DC CONVERTER INTERFACE, TESTED	4 EA	
9010222021G	PWA, AC DISTRIBUTION	1 EA	
9010222041G	PWA, I/O CONNECTOR BOARD	1 EA	
9010222051G	PWA, PA MONITOR BOARD	1 EA	
9010222081GT	PWA, PA PALLET, TESTED	4 EA	

Table 7-28 SPK, ULX XTR 380/415V RECOMMEND SPARE PARTS - 990 0160 003 (J)

Part Number	Description	Qty UM	Reference Designators
335 0486 000	O-RING, #013 EPDM 7/16'' ID NOM	4 EA	
359 1591 000	FLUID COUPLER, FEMALE SSR605	1 EA	
359 1875 000	FLUID COUPLER, MALE SSR601	1 EA	
398 0489 000	FUSE, CART 5X20MM 2A SLOW	5 EA	
398 0496 000	FUSE, CART 5X20MM 4A SLOW	5 EA	
398 0586 000	*FUSE 12AMP 600V FAST (10X38)	5 EA	
398 0777 001	FUSE 8A 250V FAST 5MM X 20MM	5 EA	
448 0868 000	AIR FILTER 14 X 20 X .88	6 EA	
510 0794 000	CAP, MOTOR 2.5UF 230V	1 EA	
570 0405 000	CNTOR 60AMP 3P 240V	1 EA	
606 1136 080	CKT BRKR 8 AMPS 2P 480VAC	1 EA	
606 1139 200	CKT BRKR 20 AMPS 4P 480VAC	1 EA	
606 1290 080	CKT BRKR 80 AMPS 4P 480VAC	1 EA	
629 0093 000	SENSOR, LIQUID LEVEL, FLOAT	1 EA	
629 0181 000	METER, FLOW 1 IN, 8-60 GPM	1 EA	
943 5601 235	SENSOR, TEMP	1 EA	
943 5601 710	REPLACEMENT FAN AND CABLE	1 EA	
9710039008T	ASM, PS MODULE, TESTED	1 EA	
971 0040 010	MOV, 3PH 400V WYE MAXIVA ULX	1 EA	

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Table 7-29 SBK, ULX TCU PC KIT SPARE BOARDS - 990 0160 004 (E)

Part Number	Description	Qty UM	Reference Designators
746 0533 000	*PANEL PC, PDX-057T (PRE-LOADED)	0 EA	
9010221221G	PWA, INRUSH LIMITER	1 EA	
9010222101G	PWA, 4PA BACKPLANE BOARD	1 EA	
9010222131G	PWA, IPA BACKPLANE	1 EA	
9010222141GT	PWA, CUSTOMER I/O BOARD TESTED	1 EA	
9010222271G	PWA, PRE DRIVER SIGNAL INTERCONNECT	1 EA	
9010222601G	PWA, CONTACTOR CONTROL CE	1 EA	
9010222701GT	PWA, FAN CONTROL BOARD CE, TESTED	1 EA	
9710039011T	ASM,DIGITAL/ANALOG I/O, TESTED	1 EA	
9710039018T	ASM, CUSTOMER I/O, TESTED	1 EA	
9710039020T	ASM, TRITON, RF DET., TESTED	1 EA	
9710039021T	ASM, TRITON, EXC. SWITCHER, TESTED	1 EA	
9710039022T	ASM, TRITON, PSU MON., TESTED	1 EA	
9710039033T	ASM-SUB-SW MODULE-MAXIVA-UCP, TESTED	1 EA	
9710039040T	ASSY, MAIN CNTL MOD ULX, TESTED	1 EA	
9710039156T	ASSY,PROCESS CONTROL MODULE II, ULX, TESTED	1 EA	

Table 7-30 ASM-SUB-SW MODULE-MAXIVA-UCP, TESTED - 9710039033T (A)

Part Number	Description	Qty UM	Reference Designators
9010221101GT	PWA, USER INTERFACE, TESTED	1 EA	
971 0039 037	ASM_SUB_SWITCH_MODULE_UCP_L-BAND_UAX_ULX_VLX	1 EA	

Table 7-31 ASSY, MAIN CNTL MOD ULX, TESTED - 9710039040T (C)

Part Number	Description	Qty UM	Reference Designators
732 0537 000	MEMORY, COMPACTFLASH 2GB TYPE-1	1 EA	
861 1141 032	S/W, UCP, MCM, ULX	0 DWG	
971 0039 029	*ASM-SUB-MAIN CONTROL MODULE II_UCP	1 EA	

Table 7-32 ASSY,PROCESS CONTROL MODULE II, ULX, TESTED - 9710039156T (A)

Part Number	Description	Qty UM	Reference Designators
861 1141 162	S/W,UCP,PCM2 ULX	0 DWG	
971 0039 071	ASSY,PCM2 SD CARD, BASE IMAGE	1 EA	
971 0039 100	*ASM-SUB-PROCESS CONTROL MODULE II	1 EA	

Table 7-33 ASSY,PCM2 SD CARD, BASE IMAGE - 971 0039 071 (A)

Part Number	Description	Qty UM	Reference Designators
732 0516 000	MEMORY CARD, MICROSD, 2GB	1 EA	
861 1140 082	PCM2 BASE IMAGE	0 DWG	

Table 7-34 *ASM-SUB-PROCESS CONTROL MODULE II - 971 0039 100 (C1)

Part Number	Description	Qty UM	Reference Designators
086 0001 002	THREADLOCKER, MEDIUM STRENGTH	0 EA	
302 0803 006	SEMS, PHMS M3-0.5 X 6 SST	2 EA	
33-351	EMI CLIP, SMALL SINGLE	3 EA	
358 1214 000	SCREWLOCK, M/F 4-40X3/16''	2 EA	2#J3
9010221321G	*PWA, PROCESSOR CONTROL MODULE II	1 EA	
943 5600 015	PANEL-REAR-PCM_UCP	1 EA	

Table 7-35 *PWA, PROCESSOR CONTROL MODULE II - 9010221321G (F)

Part Number	Description	Qty UM	Reference Designators
000 0000 010	BOM NOTE:	13 DWG	C117 C132 CR5 CR6 J14 J17 R39 R118 R123 R143 R144 R171 R183

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381 0155 000	PNP, EPITAXIAL IC = -1ADC	2 EA	Q1 Q2
383 0277 000	IC, LM4040CIM3-2.5	1 EA	CR7
383 0547 000	IC, LM50C	1 EA	U12
383 0667 000	IC, LOGIC GATE INVERTER	2 EA	U8 U9
383 0706 000	IC, LTC3025 ESD	2 EA	U33 U34
383 0740 000	IC, LAN9514 (QFN-64)	1 EA	U20
383 0784 000	IC, TS3USB221 (SON-10)	1 EA	U41
383 0786 000	IC, 74LVC244 (QFN-20)	6 EA	U7 U21 U25 U28 U31 U35
383 0799 000	IC, MCP2515 ESD	1 EA	U42
383 0813 000	IC, TPS73118 ESD	1 EA	U30
383 0814 000	IC, TPS3307-25D ESD	2 EA	U36 U40
383 0823 000	IC, 74LVC1G125	14 EA	U2 U10 U14 U15 U16 U18 U22 U24 U27 U29 U32 U43 U46 U47
383 0825 000	IC, SN65HVD230	1 EA	U44
383 0909 000	IC, BCM5222KQMG ESD	1 EA	U39
383 1021 000	IC, AD7888 ESD	1 EA	U13
383 1115 000	IC, ICS524MILF ESD	2 EA	U17 U19
383 1239 000	IC,VOLT DETECTOR,FIXED,+1.142V,CMOS	1 EA	U37
383 1252 000	ETHERNET SWITCH, 10/100 6-PORT	1 EA	U5
383 1253 000	XCVR 250KBPS 1UA RS232 3/5.5V	3 EA	U11 U38 U45
383 1505 000	IC, DUAL USB UART/ FIFO	1 EA	U4
384 1174 000	LED, RED/GRN T1 RTANG	1 EA	DS1
385 0001 000	DIODE, RECT MMBD4148 (SOT-23)	5 EA	CR1 CR2 CR3 CR4 CR8
387 0138 000	DIODE, TVS 0603 18WVDC 3PF	8 EA	RV1 RV2 RV3 RV4 RV5 RV6 RV7 RV8
389 0033 000	LED, RED, 1.0MM RECT 0603 ESD	7 EA	DS2 DS3 DS5 DS6 DS7 DS8 DS14
389 0034 000	LED, GRN, 1.0MM RECT 0603 ESD	3 EA	DS4 DS10 DS13
389 0037 000	LED, YEL, 1.0MM RECT 0603	3 EA	DS9 DS11 DS12
393 0119 000	EEPROM, 93LC66 ESD	1 EA	U3
393 0178 000	IC, M25P20 (SOIC-8)	1 EA	U6
393 0314 000	FPGA, XC3S250E (TQFP-144)	1 EA	U23
407 0004 000	BATTERY HOLDER, COIN CELL SMT	1 EA	BT1
410 0509 006	STANDOFF, 6MM SNAP-IN (NYLON)	2 EA	1/MTG5 1/MTG9
415 0011 000	BEAD, FERRITE CHIP SMT 0805	6 EA	RFC4 RFC10 RFC12 RFC13 RFC14 RFC15
415 0012 000	BEAD, FERRITE CHIP SMT 1206	10 EA	RFC1 RFC2 RFC3 RFC5 RFC6 RFC7 RFC8 RFC9 RFC11 RFC16
444 3069 000	OSC, TTL CLOCK, 25MHZ, SMT	1 EA	U26
445 0056 000	CERAMIC RESONATOR, 6.00MHZ, SMT	1 EA	U1
478 0480 000	XFMR, AUTO 10/100/1000BASE-T	1 EA	T1
486 0006 000	JACK, RJ45 2-PORT W/LEDS	2 EA	J4 J5
515 0180 301	CAP 1000PF 0603 X7R 50V 10%	6 EA	C80 C121 C154 C157 C168 C175
515 0180 401	CAP 0.01UF 0603 X7R 50V 10%	37 EA	C8 C10 C11 C13 C18 C21 C25 C31 C32 C34 C37 C38 C41 C46 C48 C57 C73 C79 C85 C98 C101 C104 C112 C119 C123 C128 C133 C139 C144 C147 C148 C158 C159 C161 C163 C171 C172
515 0180 413	CAP 0.033UF 0603 X7R 25V 10%	1 EA	C15
515 0180 501	CAP 0.1UF 50V 10% X7R 0603	115 EA	C1 C2 C3 C4 C5 C6 C7 C9 C12 C14 C16 C20 C22 C23 C24 C26 C27 C28 C29 C30 C33 C35 C36 C40 C43 C45 C49 C50 C52 C53 C54 C55 C56 C58 C59 C60 C61 C62 C63 C64 C65 C67 C68 C69 C70 C71 C72 C74 C76 C77 C78

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			C81 C82 C83 C84 C86 C87 C88 C89 C90 C91 C92 C93 C94 C95 C96 C97 C100 C102 C103 C105 C106 C107 C108 C109 C110 C111 C113 C114 C115 C116 C118 C124 C125 C126 C127 C129 C130 C131 C134 C136 C140 C141 C142 C143 C145 C146 C149 C150 C151 C152 C153 C155 C156 C160 C162 C164 C167 C176 C177 C178 C182 C183 C184 C185
515 0189 000	CAP 22UF 1206 X5R 6.3V 20%	4 EA	C17 C19 C120 C138
515 0192 601	CAP 1UF 0603 X5R 16V 10%	12 EA	C39 C47 C66 C75 C99 C122 C165 C166 C169 C170 C173 C174
515 0193 000	CAP 100UF 1210 6.3V X5R 20%	2 EA	C135 C137
526 0394 000	CAP, 100UF 16V 20% SMT 7343	6 EA	C42 C44 C51 C179 C180 C181
545 0309 203	RES 121 OHM 1% 1/4W 1206	1 EA	R201
545 0331 111	RES 26.7 OHM 1% 1/10W 0603	2 EA	R10 R13
545 0331 125	RES 49.9 OHM 1% 1/10W 0603	51 EA	R5 R9 R11 R14 R15 R18 R20 R22 R23 R24 R25 R29 R30 R33 R34 R35 R37 R38 R40 R46 R47 R48 R60 R64 R65 R66 R67 R68 R70 R71 R72 R81 R95 R100 R101 R102 R103 R104 R107 R113 R142 R187 R191 R194 R196 R197 R198 R199 R200 R202 R203
545 0331 201	RES 100 OHM 1% 1/10W 0603	4 EA	R17 R19 R27 R28
545 0331 205	RES 150 OHM 1% 1/10W 0603	2 EA	R21 R204
545 0331 210	RES 237 OHM 1% 1/10W 0603	1 EA	R76
545 0331 217	RES 475 OHM 1% 1/10W 0603	1 EA	R3
545 0331 219	RES 562 OHM 1% 1/10W 0603	1 EA	R91
545 0331 235	RES 226 OHM 1% 1/10W 0603	2 EA	R87 R112
545 0331 301	RES 1K OHM 1% 1/10W 0603	5 EA	R7 R45 R49 R137 R210
545 0331 304	RES 1.3K OHM 1% 1/10W 0603	1 EA	R195
545 0331 305	RES 1.5K OHM 1% 1/10W 0603	3 EA	R8 R106 R177
545 0331 308	RES 2K OHM 1% 1/10W 0603	1 EA	R1
545 0331 309	RES 2.21K OHM 1% 1/10W 0603	1 EA	R2
545 0331 317	RES 4.75K OHM 1% 1/10W 0603	6 EA	R12 R16 R26 R31 R32 R132
545 0331 401	RES 10K OHM 1% 1/10W 0603	21 EA	R6 R42 R44 R51 R52 R54 R57 R63 R77 R83 R120 R160 R163 R167 R168 R175 R176 R208 R209 R215 R216
545 0331 403	RES 12.1K OHM 1% 1/10W 0603	2 EA	R58 R73
545 0331 405	RES 15K OHM 1% 1/10W 0603	5 EA	R41 R43 R50 R53 R134
545 0331 410	RES 23.7K OHM 1% 1/10W 0603	2 EA	R166 R181
545 0331 417	RES 47.5K OHM 1% 1/10W 0603	1 EA	R193
545 0331 459	RES 40.2K OHM 1% 1/10W 0603	1 EA	R138
545 0331 487	RES 78.7K OHM 1% 1/10W 0603	1 EA	R145
545 0331 488	RES 80.6K OHM 1% 1/10W 0603	1 EA	R139
545 0331 489	RES 12.4K OHM 1% 1/10W 0603	1 EA	R59
545 0331 501	RES 100K OHM 1% 1/10W 0603	1 EA	R217
545 0331 601	RES 1MEG OHM 1% 1/10W 0603	1 EA	R4
545 0331 999	RES 0 OHM JUMPER 0603	5 EA	R36 R96 R105 R114 R126
545 0369 109	RES 22.1 OHM 1% 1/16W 0402	61 EA	R55 R56 R61 R62 R74 R75 R78 R79 R80 R82 R84 R85 R86 R88 R89 R90 R92 R93 R94 R97 R98 R99 R108 R109 R110 R111 R115 R116 R117 R119 R121

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545 0369 317	RES 4.75K OHM 1% 1/16W 0402	17 EA	R122 R124 R125 R127 R128 R129 R130 R131 R133 R135 R136 R140 R141 R146 R147 R148 R149 R150 R151 R152 R153 R154 R155 R156 R157 R158 R159 R161 R162 R165 R164 R169 R170 R172 R173 R174 R178 R179 R180 R184 R188 R189 R190 R211 R212 R213 R214
545 0369 999	RES 0 OHM JUMPER 0402	4 EA	R182 R185 R186 R192
561 0002 007	POSISTOR 0.5 AMP 15VDC 1812	4 EA	R69 R205 R206 R207
603 0006 000	DIPSWITCH, 4-SPST SMT-8	1 EA	S2
604 1163 000	SW, PB MOM SPST-NO TACT (SMT)	1 EA	S3
610 0877 000	HDR, 2C VERT 1ROW UNSHR	1 EA	JP1
610 1160 000	HDR, 4C VERT 1ROW FRICTION	1 EA	J13
610 1401 020	HDR, 20C 2ROW VERTICAL (SYS 50)	1 EA	J11
610 1459 000	HDR, 60C 2ROW VERTICAL	1 EA	J10
611 0016 000	HEADER, 14C, 2MM, VERTICAL	1 EA	J15
611 0160 000	PLUG, 100C 2 ROW VERTICAL SMT	2 EA	XA1J1 XA1J2
612 1184 000	JUMPER SHUNT, 2C, 0.1'' PITCH	1 EA	1/JP1
612 1594 000	JACK RJ45 1-PORT G/GY RT ANG	2 EA	J1 J6
612 1631 000	CONN, MICROSD CARD (SMT)	1 EA	J8
612 2139 001	RECP, D STRT 9C PCB	1 EA	J2
612 2243 009	RECP/RECP, D, 9C/9C, METAL	1 EA	J3
612 2302 000	RECP, USB-A RTANG PCB FLAG	4 EA	J7 J9 J12 J16
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
660 0054 000	BATTERY 3V LITHIUM COIN CR2032	1 EA	1/BT1
746 0343 000	SBC, TS-4700	1 EA	
801 0221 321	SCH, PROCESSOR CONTROL MODULE II	0 DWG	
8010221323G	PWB, PROCESSOR CONTROL MODULE II	1 EA	
880 0221 321	TP, PCM-II TEST PROCEDURE	DWG	

Table 7-36 !FORMAT EXCITER APEX M2X DVBT - 995 0063 001 (P)

Part Number	Description	Qty UM	Reference Designators
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
861 1135 202	APEX M2X SW/FW DVB COMPLETE APP	0 DWG	
880 0063 001	TEST PROCEDURE, M2X	0 DWG	
971 0035 003	KIT, BATTERY BACKUP	0 EA	
981 0274 001	EXCITER, APEX M2X BASIC	1 EA	
9810274006G	ASSY, IPA6800+, ASI OVER IP (M2X)	0 EA	
9810274008G	ASSY, IPZ6800+, ASI OVER IP (M2X\UAX\VAX)	0 EA	
9810274105G	ASSY, SRD6800+, SAT RECEIVER, W/ASI IN	0 EA	
9810274107G	ASSY, SRZ6800+, SAT RECEIVER, W/ASI IN	0 EA	
988 2624 010	DP, M2X DVB-T/H	1 EA	
9950063001WI	WI, M2X EXCITER, FORMAT	0 DWG	

Table 7-37 KIT, BATTERY BACKUP - 971 0035 003 (A)

Part Number	Description	Qty UM	Reference Designators
302 0803 006	SEMS, PHMS M3-0.5 X 6 SST	4 EA	
9010215091G	PWA, BATTERY BACKUP	1 EA	

Table 7-38 PWA, BATTERY BACKUP - 9010215091G (D1)

Part Number	Description	Qty UM	Reference Designators
055 0190 009	*RTV SILICONE, CLEAR	0 EA	#BT1
254 0002 000	BUS WIRE, 20AWG, SOLID TINNED CU	.166 FT	2/BT1
356 0089 000	CABLE TIE, 5.6'''LG, NYLON	2 EA	2/BT1
522 0593 000	*CAP 3300UF 25V 20% (16X25)	1 EA	C1

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560 0122 022	POSISTOR 4 AMP 30VDC RECT DISC	1 EA	R2
610 0746 000	HDR, 20C VERT 2ROW UNSHR	1 EA	J1
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
660 0113 000	BAT PACK 4.8V 4AA NIMH 2500MAH	1 EA	BT1
801 0215 091	SCH, BATTERY BACKUP	0 DWG	
9010215092G	*PWA, BATTERY BACKUP, SMT	1 EA	

Table 7-39 EXCITER, APEX M2X BASIC - 981 0274 001 (AD)

Part Number	Description	Qty UM	Reference Designators
026 6010 007	GROMMET STRIP, 0.063	0.15 FT	
053 0016 000	CARTON, TRIPLE WALL, 28X25X10.5	1 EA	
055 0100 005	*THERMAL COMPOUND, 8OZ JAR	0 EA	
086 0001 002	THREADLOCKER, MEDIUM STRENGTH	0 EA	
086 0001 004	THREADLOCKER, HIGH STRENGTH	0 EA	
256 0227 000	CABLE, FFC 40C, 2ROW 61MM LONG	3 EA	W3 W4 W5
302 0803 006	SEMS, PHMS M3-0.5 X 6 SST	9 EA	
302 0804 008	SEMS, PHMS M4-0.7 X 8 SST	8 EA	
303 4104 016	SCREW, PHMS M4-0.7 X16 (SST)	1 EA	
303 4203 006	SCREW, FHMS M3-0.5 X 6	32 EA	
303 4204 050	SCREW, FHMS M4-0.7 X 50 (SST)	4 EA	
304 0174 000	NUT, JAM, BRASS 1/2-28	7 EA	
306 0028 000	LOCKNUT, KEP HEX M4-0.7 (SST)	10 EA	
307 0001 040	NUT, STD HEX M4-0.7 (SST)	2 EA	
311 0011 040	WASHER, FLAT M4 SST (DIN125)	4 EA	
314 0014 000	WASHER, INT LOCK 1/2	7 EA	
315 0023 040	WASHER, EXT LOCK M4	3 EA	
33-351	EMI CLIP, SMALL SINGLE	19 EA	
336 1330 000	STDOFF-M/F-4.5MM HEX-M3X0.5X5L	13 EA	
337 0005 000	<*>SEMS, SHMS M3-0.5 X 6 SST	3 EA	
35-733	STUD,BALL,TREELOCK	4 EA	
356 0216 000	CABLE TIE, 5.6'' NYLON NATURAL	4 EA	
358 1024 000	CABLE TIE MOUNT, 4-WAY	2 EA	
358 1214 000	SCREWLOCK, M/F 4-40X3/16''	2 EA	
410 0471 000	STANDOFF, HEX M3 X 16 M/F	6 EA	
426 0149 000	VIBRATION MOUNT M/F .375D X .625H	4 EA	
430 0325 000	FAN GUARD, 80MM WIRE-FORM	2 EA	
430 0687 000	FAN, 80MM X 32MM 12VDC	2 EA	
610 1425 003	RECP, 3C 1ROW VERTICAL	2 EA	
646 0665 000	LABEL, INSPECTION	1 EA	
843 5588 001	WIRING DIAGRAM UEP	0 DWG	
843 5588 038	FAMILY TREE, UEP	0 DWG	
861 1135 302	APEX M2X SW/FW CTTB COMPLETE APP	0 DWG	
880 0063 001	TEST PROCEDURE, M2X	0 DWG	
9010213011G	*PWA, MCF5484 UC MODULE	1 EA	
9010215101G	*PWA, UP/DOWN CONVERTER	1 EA	
9010215181G	*PWA, SIGNAL PROCESSOR	1 EA	
943 5588 002	CHASSIS_M2X	1 EA	
943 5588 020	HEATSINK, AMPLIFIER MODULE	1 EA	
943 5588 030	BLOCK-MOUNTING-PCA_UEP	6 EA	
943 5588 045	PANEL, DIVIDER	1 EA	
943 5588 062	BRACKET, AC CORD	1 EA	
943 5588 068	PLATE, TRAVEL LIMIT	1 EA	
943 5588 081	INSERT, M2X TOP PACKING	1 EA	
943 5588 082	INSERT, M2X BOTTOM PACKING	1 EA	
943 5602 600	SPACER, FAN	4 EA	
952 9248 001	CABLE, KIT UEP	1 EA	
971 0035 004	ASM-SUB-FRONT-CONTROL-PANEL-CTR UEP	1 EA	
971 0035 007	ASM-POWER MODULE	1 EA	

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9710035011G	ASM-SUB-TX/IO INTERFACE MODULE	1 EA
971 0035 013	ASM-SUB-BLANK PANEL A	1 EA
971 0035 014	ASM-SUB-BLANK PANEL B	1 EA
971 0035 016	ASSY, M2X FRONT PANEL	1 EA
971 0035 018	ASSY, M2X PFRU	1 EA
971 0035 019	ASM-SUB-COVER-NONVENTED	1 EA
9810274001WI	WI, M2X BASIC	0 DWG

Table 7-40 *PWA, SIGNAL PROCESSOR - 9010215181G (J)

Part Number	Description	Qty UM	Reference Designators
360 0073 000	HEAT SINK, 40X40X13 MM BLACK	1 EA	#U40
360 0073 001	HEAT SINK, 30X30X10 MM BLACK	1 EA	#U43
404 1007 000	HOLDER, BATTERY 20MM COIN CELL	1 EA	BT1
410 0492 006	STANDOFF, PEM, M3-0.5 X 6 (KFSE-M3-6)	2 EA	
445 0055 000	OCXO, 54MHZ, 3.3V HCMOS ESD	1 EA	U61
516 0054 000	CAP, DISC 0.001UF 1KV 10% Z5U	4 EA	C2 C6 C189 C204
610 0900 000	HDR, 3C VERT 1ROW UNSHR	1 EA	JP1
610 1110 000	HDR, 8C VERT 2ROW UNSHR	1 EA	J7
610 1401 040	HDR, 40C 2ROW VERTICAL (SYS 50)	3 EA	J23 J24 J25
610 1402 020	*HDR (FFC), 20C 2ROW RT ANG	1 EA	J18
612 1184 000	JUMPER SHUNT, 2C, 0.1'' PITCH	1 EA	1/JP1
612 2152 000	RECP, RJ45 W/ INTEGRAL LED	2 EA	J1 J20
612 2243 009	RECP/RECP, D, 9C/9C, METAL	1 EA	J5
612 2342 000	RECP, 80C, RT-ANG, BD-BD	2 EA	J21 J22
612 2347 000	RECP, MCX FEMALE 50 OHMS	10 EA	J2 J3 J13 J14 J15 J16 J17 J19 J26 J27
620 2930 000	RECEPTACLE RT ANGLE BNC	1 EA	J6
626 0005 000	RECP, BNC, STACKED, THRU-PANEL, 50 OHM	1 EA	J4
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
660 0054 000	BATTERY 3V LITHIUM COIN CR2032	1 EA	#BT1
801 0215 181	SCH, SIGNAL PROCESSING	0 DWG	
9010215182G	*PWA, SIGNAL PROCESSOR, SMT	1 EA	
9306-0014	CONN HDR,2X7 POS .10CTRS	1 EA	J9

Table 7-41 !FORMAT EXCITER APEX M2X ISDBT - 995 0063 002 (P)

Part Number	Description	Qty UM	Reference Designators
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
861 1135 282	APEX M2X SW/FW ISDB-T COMPLETE APP	0 DWG	
880 0063 001	TEST PROCEDURE, M2X	0 DWG	
971 0035 003	KIT, BATTERY BACKUP	0 EA	
981 0274 001	EXCITER, APEX M2X BASIC	1 EA	
9810274006G	ASSY, IPA6800+, ASI OVER IP (M2X)	0 EA	
9810274008G	ASSY, IPZ6800+, ASI OVER IP (M2X\UAX\VAX)	0 EA	
9810274105G	ASSY, SRD6800+, SAT RECEIVER, W/ASI IN	0 EA	
9810274107G	ASSY, SRZ6800+, SAT RECEIVER, W/ASI IN	0 EA	
988 2624 003	DP, M2X ISDB-T	1 EA	
9950063001WI	WI, M2X EXCITER, FORMAT	0 DWG	

Table 7-42 !FORMAT EXCITER APEX M2X ATSC - 995 0063 004 (N)

Part Number	Description	Qty UM	Reference Designators
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
861 1135 132	APEX M2X SW/FW ATSC COMPLETE APP	0 DWG	
880 0063 001	TEST PROCEDURE, M2X	0 DWG	
971 0035 003	KIT, BATTERY BACKUP	1 EA	
9710035031G	KIT, SFN OPTION	0 EA	
981 0274 001	EXCITER, APEX M2X BASIC	1 EA	
9810274006G	ASSY, IPA6800+, ASI OVER IP (M2X)	0 EA	

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9810274008G	ASSY, IPZ6800+, ASI OVER IP (M2X\UAX\VAX)	0 EA
9810274105G	ASSY, SRD6800+, SAT RECEIVER, W/ASI IN	0 EA
9810274107G	ASSY, SRZ6800+, SAT RECEIVER, W/ASI IN	0 EA
988 2624 002	DP, UEP, ATSC	1 EA
9950063001WI	WI, M2X EXCITER, FORMAT	0 DWG

Table 7-43 !FORMAT EXCITER APEX M2X ATV - 995 0063 005 (L1)

Part Number	Description	Qty UM	Reference Designators
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
861 1135 242	APEX M2X SW/FW ATV COMPLETE APP	0 DWG	
880 0063 001	TEST PROCEDURE, M2X	0 DWG	
971 0035 003	KIT, BATTERY BACKUP	0 EA	
9710035020G	ASSY, ATV INPUT OPTION	1 EA	
981 0274 001	EXCITER, APEX M2X BASIC	1 EA	
988 2624 004	DP, M2X ANALOG	1 EA	
9950063001WI	WI, M2X EXCITER, FORMAT	0 DWG	

Table 7-44 !FORMAT EXCITER APEX M2X DVBT2 - 995 0063 009 (E)

Part Number	Description	Qty UM	Reference Designators
646 2110 000	BARCODE, SN_ITEM_REV	1 EA	
861 1135 362	APEX M2X SW/FW DVB-T2 COMPLETE	0 DWG	
880 0063 001	TEST PROCEDURE, M2X	0 DWG	
9010215281G	*PWA, DVB-T2 FPGA EXPANSION	1 EA	
971 0035 003	KIT, BATTERY BACKUP	0 EA	
981 0274 001	EXCITER, APEX M2X BASIC	1 EA	
9810274006G	ASSY, IPA6800+, ASI OVER IP (M2X)	0 EA	
9810274008G	ASSY, IPZ6800+, ASI OVER IP (M2X\UAX\VAX)	0 EA	
9810274105G	ASSY, SRD6800+, SAT RECEIVER, W/ASI IN	0 EA	
9810274107G	ASSY, SRZ6800+, SAT RECEIVER, W/ASI IN	0 EA	
988 2624 011	DP, M2X DVB-T2	1 EA	
9950063001WI	WI, M2X EXCITER, FORMAT	0 DWG	

Table 7-45 ASSY, PUMP MODULE, HE II 50/60HZ, 208-240V/308-415V - 995 0333 004 (A)

Part Number	Description	Qty UM	Reference Designators
981 5607 004	ASSY, PUMP MODULE, BASIC HE II	1 EA	
988 2625 002	DP, PUMP MODULE HE II	1 EA	
817 2350 172	SPEC, INVERTER PROG INSTR	0 DWG	
880 0333 000	TP, HE PUMP MODULE	0 DWG	
990 0160 014	SPK, ULX/VLX HI EFFICIENCY PUMP MODULE, HE II	0 EA	
9950333001GWI	WI, ULX/VLX HIGH EFFICIENCY PUMP MODULE	0 DWG	

Table 7-46 ASSY, PUMP MODULE, BASIC HE II - 981 5607 004 (D)

Part Number	Description	Qty UM	Reference Designators
000 0000 010	BOM NOTE:	0 DWG	
021 7510 002	HOSE, 1/2'' ID, BLUE	2.5 FT	
021 7510 004	HOSE, GEN PURP EPDM 1.25ID RED	1.25 FT	
299 0014 000	TAPE, PVC VINYL CLOSED	RL	
336 1254 000	*HOSE CLAMP, (MINI) SST, SAE-6	2 EA	
354 0190 000	NUT, WIRE YEL 18-12 AWG 600V	8 EA	
358 1036 000	*HOSE CLAMP, SST, SAE-152	1 EA	
358 1316 000	HOSE CLAMP, SST, SAE-24	8 EA	
358 3025 000	HOSE BARB, 0.50H X 0.50MPT	1 EA	
359 1154 000	BUSHING, 1/2 X 1/4 MALE TO	1 EA	
359 1617 000	VALVE, BLOWDOWN BALL	2 EA	
359 1619 000	VALVE, PRESSURE RELIEF 75 PSI	1 EA	
359 1621 000	VALVE, AUTOMATIC AIR VENT	1 EA	
359 1625 000	CROSS, FXFXFXF 0.500 BRZ/BRASS	1 EA	

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359 1631 000	ELBOW BRS 90DEG 0.500F X 0.500M	2 EA
359 1632 000	ADAPTER, FXM 0.250 X 0.250 BRASS	2 EA
359 1634 000	ELBOW 1.25"ID HOSE X 1.25"MNPT	2 EA
359 1635 000	HOSE BARB, 0.50H X 0.50FPT	1 EA
629 0202 000	GAUGE, PRESSURE 0-100 PSI	2 EA
646 1683 000	LABEL, SAFETY GROUND	2 EA
778-225-003	HOLE BUNG DP-1000	2 EA
817 2150 037	GROUNDING PLATE	1 EA
843 5607 462	SKID, PUMP MODULE	0 DWG
943 5607 436	BACK	1 EA
943 5607 437	BASE	1 EA
943 5607 449	ASSY, INPUT PLUMBING, PUMP MODULE, HE	1 EA
943 5607 450	ASSY, OUTPUT PLUMBING, PUMP MODULE, HE	1 EA
943 5607 463	BRACKET, TANK	1 EA
943 5607 631	LABEL KIT, PUMP MODULE	1 EA
971 5607 015	KIT, AUX. PUMP MODULE PARTS	1 EA
359 1620 000	TANK, EXPANSION IN-LINE 2 GAL	1 EA
708 0061 020	MOTOR PUMP 126 2HP	2 EA
971 5607 014	ASSY, CONTROL UNIT, PUMP MODULE HE II	1 EA

Table 7-47 KIT, AUX. PUMP MODULE PARTS - 971 5607 015 (A)

Part Number	Description	Qty UM	Reference Designators
335 0489 000	FILTER, 304 SST, 20 MESH	1 EA	
358 3185 000	PLUG WHT 1.093/1.125 HOLE	4 EA	
359 1638 000	WASHER, FILTER GARDEN HOSE BRS	2 EA	
424 0677 000	HOSE, RUBBER 6' W/3/4" CPLGS	2 EA	

Table 7-48 ASSY, CONTROL UNIT, PUMP MODULE HE II - 971 5607 014 (C)

Part Number	Description	Qty UM	Reference Designators
055 0120 227	CONDUIT FLEXIBLE 1/2 IN.	7 FT	
055 0120 231	CONN, STRAIGHT 1/2	2 EA	
055 0120 373	CONN 1/2 IN. 90 DEG	2 EA	
350 0046 000	RIVET 0.156 DIA, DOME HEAD, OPEN END	2 EA	
354 0026 000	LUG SPADE #10 12-10AWG YEL	8 EA	
358 1316 000	HOSE CLAMP, SST, SAE-24	1 EA	
358 3637 000	PLATE, END STOP, DIN RAIL MTG	2 EA	
358 3717 000	PLATE, END COVER (282 3-COND)	1 EA	
606 1232 150	CKT BRKR 15 AMPS 2P 240VAC	4 EA	
614 0920 000	JUMPER, 2-POLE ADJACENT 282	3 EA	
614 0923 000	TERM BLK, 2C MODULAR 282	1 EA	
614 0941 000	TERM BLK, 3C MODULAR 282	6 EA	
615 0007 000	TERM BLK, THRU, 2-POLE, GREY (264)	6 EA	
615 0008 000	TERM BLK, GROUND, 4-POLE, GRN/YEL (264)	1 EA	
638 0075 000	SENSOR, THERMISTR NTC 100K OHM	1 EA	
736 0498 000	INVERTER DRIVE, 240V 1PH 1HP	2 EA	
736 0499 000	INVERTER DRIVE, 240V 1PH 2HP	2 EA	
843 5607 530	OUTLINE DRAWING / WIRING DIAGRAM, HE II PUMP MODULE	0 DWG	
901 0227 101	PWA, PUMP CONTROL	1 EA	
917 2567 010	DIN RAIL, CUT LENGTH 360MM	1 EA	
943 5607 526	WINDOW, CONTROL ENCLOSURE	1 EA	
943 5607 527	CHASSIS, CONTROL ENCLOSURE	1 EA	
943 5607 528	COVER, CONTROL ENCLOSURE, UPPER	1 EA	
943 5607 529	COVER, CONTROL ENCLOSURE, LOWER	1 EA	
952 9253 264	CABLE HE PUMP MODULE DRY COOLER RETROFIT	1 EA	

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Table 7-49 SPK, ULX/VLX HI EFFICIENCY PUMP MODULE, HE II - 990 0160 014 (B)

Part Number	Description	Qty UM	Reference Designators
021 7510 002	HOSE, 1/2'' ID, BLUE	2 FT	
021 7510 004	HOSE, GEN PURP EPDM 1.25ID RED	2 FT	
335 0487 000	O-RING, UNION 1-1/2" VITON	4 EA	
335 0488 000	GASKET, UNION 1-1/2" EPDM	2 EA	
335 0489 000	FILTER, 304 SST, 20 MESH	1 EA	
336 1254 000	*HOSE CLAMP, (MINI) SST, SAE-6	2 EA	
354 0190 000	NUT, WIRE YEL 18-12 AWG 600V	8 EA	
358 1036 000	*HOSE CLAMP, SST, SAE-152	1 EA	
358 1316 000	HOSE CLAMP, SST, SAE-24	9 EA	
359 1617 000	VALVE, BLOWDOWN BALL	1 EA	
359 1619 000	VALVE, PRESSURE RELIEF 75 PSI	1 EA	
359 1620 000	TANK, EXPANSION IN-LINE 2 GAL	1 EA	
359 1621 000	VALVE, AUTOMATIC AIR VENT	1 EA	
424 0677 000	HOSE, RUBBER 6' W/3/4" CPLGS	2 EA	
606 1232 150	CKT BRKR 15 AMPS 2P 240VAC	4 EA	
629 0202 000	GAUGE, PRESSURE 0-100 PSI	2 EA	
638 0075 000	SENSOR, THERMISTR NTC 100K OHM	1 EA	
708 0061 020	MOTOR PUMP 126 2HP	1 EA	
708 0061 072	KIT, EPDM-CARBON/SILICON SEAL	1 EA	
736 0498 000	INVERTER DRIVE, 240V 1PH 1HP	1 EA	
736 0499 000	INVERTER DRIVE, 240V 1PH 2HP	1 EA	
9010227101T	PWA, PUMP CONTROL, TESTED	1 EA	

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Appendix-a
Cutting & Soldering Transmission Line

a

a.1 Suggested Cutting And Soldering Procedure

The purpose for this procedure is to provide guidelines for field cutting and soldering of RF transmission line used to interconnect the transmitter to the RF system.

Try to cut and flange the longest pieces first. Complete one run at a time in order to avoid accumulated errors. (i.e.: Cut, solder, and hang line from antenna port of bandpass filter to patch panel. Then cut, solder, and hang line from the amplifier output to the input port of the bandpass filter.)

Listed in Table a-1 are some tools and materials that have proven effective for RF feed line construction.

Table a-1 Tools and Materials Needed For RF Feed Line Construction

Welding Torch Set	Hacksaw and Extra Blades
Oxygen and Acetylene Tanks	Plumb Bob
Welder's Mask or Goggles	Chalk Line
Power Band Saw (can be rented) and Extra Blades	Wrenches
Silver Solder 1/16 inch diameter, 30%-45%, Hard Stay-Silv #45, Aladdin #45, p/n 086 0004 060	Crowbar
Paste flux (Engelhard Ultra-Flux 1 lb jar) p/n 086 0004 046	Rope
Muriatic Acid (quart)	Saw Horses or Cutting Table
Baking Soda (two 1-pound boxes)	Come-along or Chain-Fall Hoist
Three plastic 5-gallon buckets or containers with open tops	Ladders
Scotch Brite	Garden Hose
Steel Wool	25-Ft Tape Measure
Emery Cloth (roll type like plumber uses)	Files
Carpenters Square	Rubber Hammer
Level	Claw Hammer
Hole Saw, 1-7/8 inches, for installing directional couplers	Gloves
Safety Glasses	

NOTE: All-thread rod, hangers, angle iron or channel will be needed to support transmission line, dummy load, etc.

a.2 Line Cutback and Flange Soldering Procedure

1. Determine the flange-face to flange-face length of the transmission line run needed. If the run includes an elbow, see Figure a-1 to determine the elbow length.
2. Subtract twice the cutback dimension of the flange. This dimension varies with flange manufacturer. See Figure a-2.
3. Using one of the suggested methods for cutting the line given in Section a.3, cut the outer conductor to the length just calculated.
4. If holes in the outer conductor are needed for directional couplers, tuning paddles, etc. they should be added now with the holes properly deburred.
5. Using the suggested techniques for installing the flanges given in Section a.4, solder a flange to each end of the outer conductor.

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6. Measure the flange-face to flange-face dimension after soldering to confirm the proper length and to determine the initial length of the inner conductor.
7. Determine the length of the inner conductor by using the flange-face to flange-face dimension of the outer conductor and subtracting the dimension of the anchor connector (bullet) shown in Figure a-3. This dimension determines the proper cutback of the inner conductor for both ends of the line at the same time. do not double this dimension when subtracting from the outer conductor length.
8. Cut the inner conductor and debur the cut edges.
9. Ensure the inside of the outer conductor is clean; then insert the inner conductor. The line is ready to install.

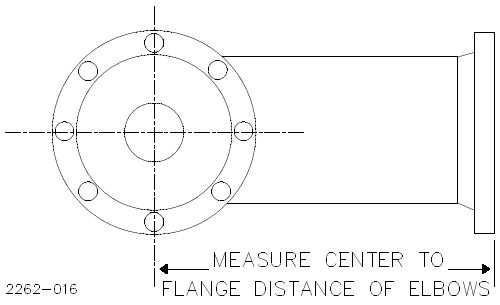


Figure a-1 Measurements When Elbows Are Used

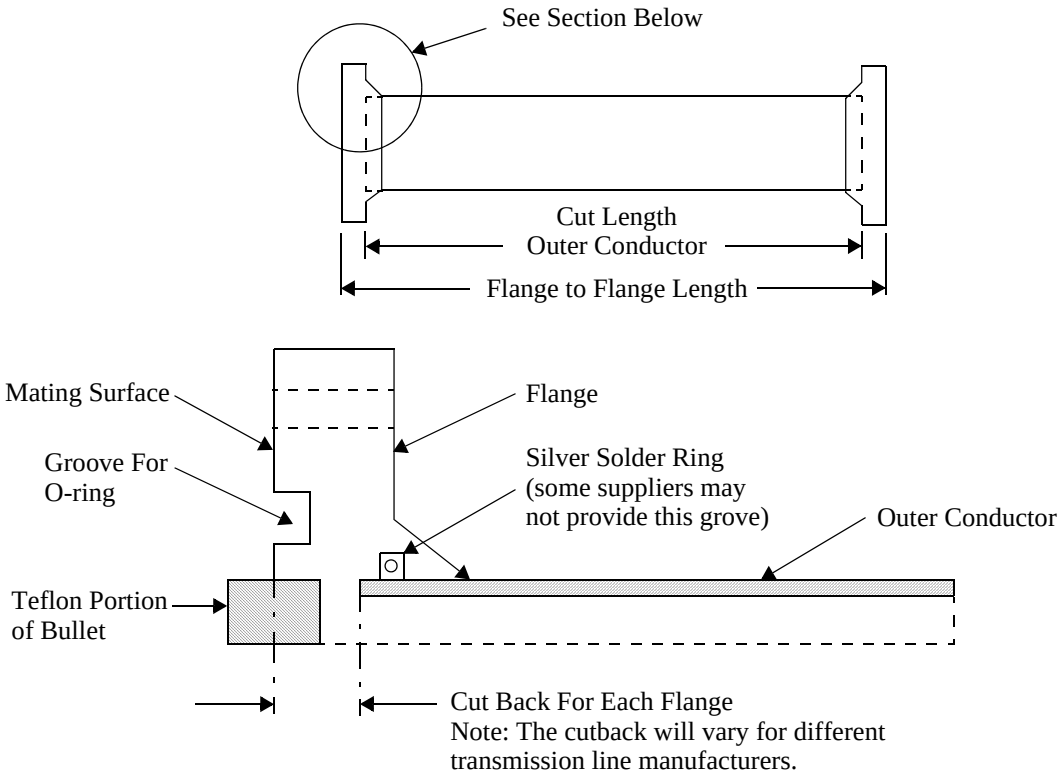
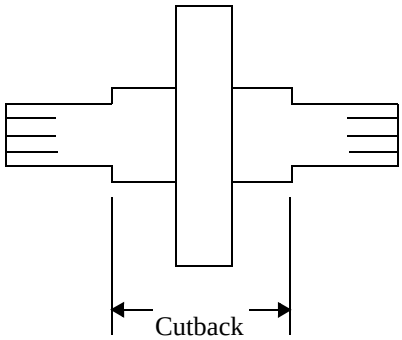


Figure a-2 Outer Conductor Measurements



The amount of cutback vary for different transmission line manufacturers.

Figure a-3 Measurement for Cutback of Inner Conductor

a.3 Cutting The Transmission Line

A square smooth cut is required. Several methods, listed below, may be used with the choice depending on tools and labor available.

1. Method 1. A hand hack saw and cast iron cutting guide are a good combination for making a cut with a minimum of tools for one or two pieces, but can be very labor intensive for putting up an entire system. See Figure a-4.
2. Method 2. Hand band saw: These popular saws can be rented or purchased. See Figure a-5.
3. Method 3. Swing arm band saw: This is a good way to go if one can be rented or borrowed. Many pipe fitters and electrical contractors own them. If the saw has an automatic feed, cut slowly. It is critical that the support saw horses be made level with the saw. Test cuts should first be made using scrap pipe or a wood 4x4 to verify that the blade is not creeping and the saw is in alignment. See Figure a-6.

   Caution

   DO NOT OVER TIGHTEN THE VISE USED WITH THESE SAWS. IT WILL BE DIFFICULT TO PUT THE FLANGE ON AN OUT OF ROUND PIPE.

4. Method 4. Tubing cutter: This is generally not recommended. Many cuts end up with crimped ends due to dull cutters or trying to cut too fast. Use with caution. Avoid if possible unless someone is available that has had a lot of experience using a tubing cutter on this type of installation. See Figure a-7.
5. Method 5. Cut off saw: These saws are similar to radial arm saws. It is rare to find one big enough to cut 6-1/8” line. The set up is similar to the swing arm band saw. See Figure a-6.

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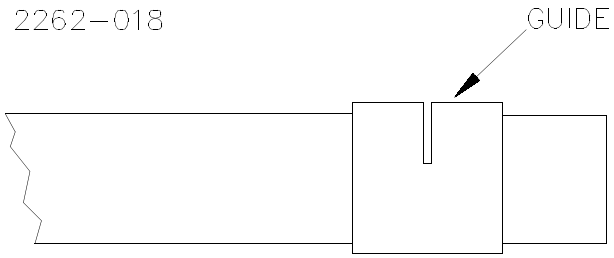

Figure a-4 Guide For Use With Hand Hack Saw

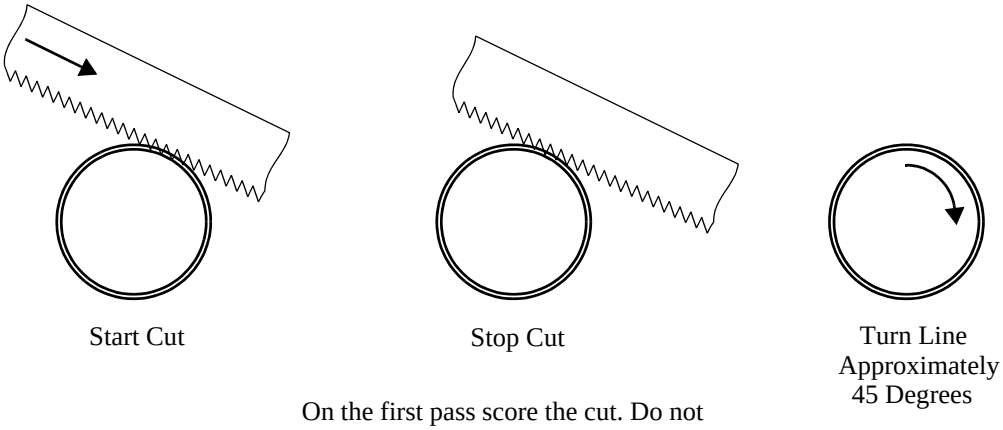
Start Cut
Stop Cut
Turn Line
Approximately
45 Degrees
On the first pass score the cut. Do not
let the blade go below the surface.
Correct Depth
Cut Too Deep
Finish cut on second pass. Keeping the blade from
falling too far below the surface keeps the cut smooth

Figure a-5 Cutting With a Hand Band Saw

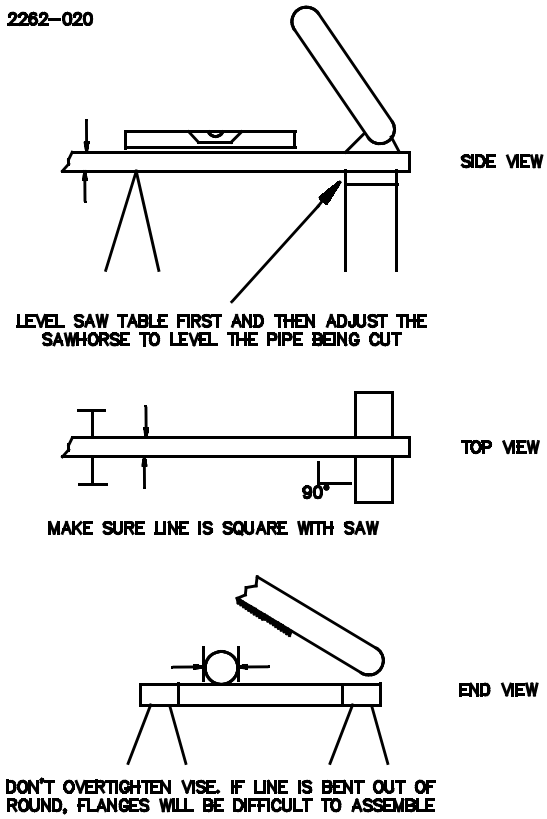
2262–020
SIDE VIEW
LEVEL SAW TABLE FIRST AND THEN ADJUST THE SAWHORSE TO LEVEL THE PIPE BEING CUT
TOP VIEW
90°
MAKE SURE LINE IS SQUARE WITH SAW
END VIEW
DON'T OVERTIGHTEN VISE. IF LINE IS BENT OUT OF ROUND, FLANGES WILL BE DIFFICULT TO ASSEMBLE

Figure a-6 Swing Arm Band Saw Cutting Tips

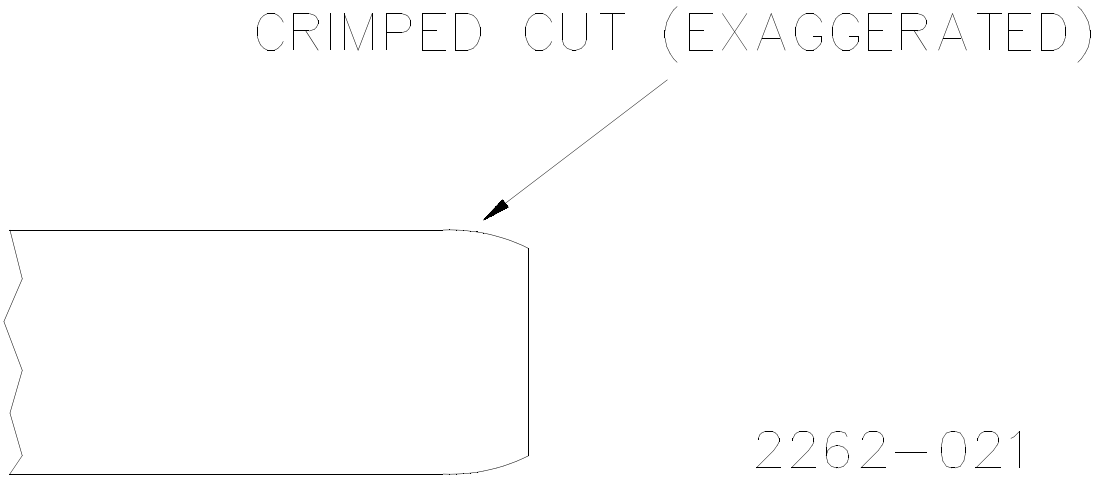

Figure a-7 Use Of Tubing Cutter Results In Crimped Cut (Exaggerated)

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a.4 Soldering Flanges

Transmission line flanges that are supplied with the optional transmission line kit are the silver solder type. Although the attachment of this type of flange may require more care and skill than the soft solder type, it has been found that the silver soldered flange provides much greater reliability. The services of a steam fitter or plumber may be helpful if personnel are not available that are experienced with silver soldering.

a.4.1 Soldering Procedure

1. The line should be free of burrs. The outer corner may be beveled slightly to make assembly of flange easier. See Figure a-8.
2. Emery cloth should be used to clean the outside of the line where it will meet the flange. Also clean the inner surface of the flange with emery cloth.
3. Insert the solder ring into the groove on the flange. If solder rings are not included with the flange, they can be made from 0.062-inch diameter silver solder wire (30-45% silver).
4. Apply a thin coat of flux to the line and to the flange.
5. Slide the flange onto the end of the outer conductor.

Warning

SKIN BURN HAZARD. TEMPERATURE OF THE HEATED LINE IN THE FOLLOWING STEPS IS QUITE HIGH AND PRECAUTIONS MUST BE TAKEN TO AVOID CONTACT WITH EXPOSED SKIN.

6. Stand the line on end (vertical) for soldering (flange to be soldered pointing down). Ensure that the flange remains square with the outer conductor.
7. Using a #3 or #4 torch tip, heat the entire circumference of the line and flange. Keep the torch moving and heat 2 or 3 inches of the line/flange at a time. Aim the torch at the copper just above the crack between the flange and the line. This will minimize the need for fill solder. If the brass flange is heated more than the copper line, the flange will expand and create an unnecessary gap to fill with solder. Use caution. There is a fine line between melting the solder and melting the brass flange or burning a hole in the copper. The solder will pull up into the joint from the solder ring by capillary action. Once it starts to flow, do not stop until the entire circumference of the joint has solder appearing in it. If the solder from the internal solder ring does not “wick up” and become visible at the joint after a few minutes, a small amount of solder can be applied to the joint to enhance the heat transfer. See Figure a-9.

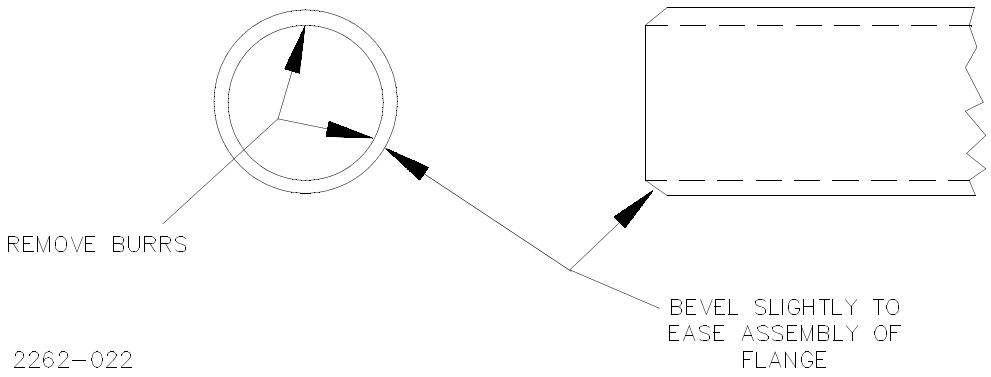

Figure a-8 Bevel Cut End and Remove Burs

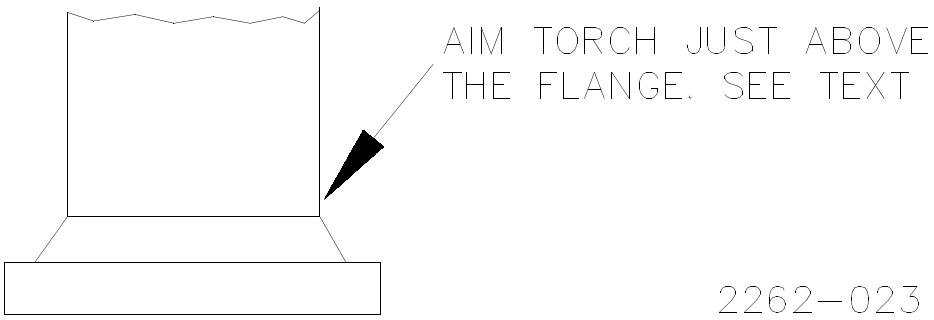

Figure a-9 Torch Aiming Location

a.5 Cleaning The Soldered Joint

Vigorous scrubbing with a wire brush and steel wool will remove torch black with good results. In addition, cleaning with an acid solution can make this job easier. The procedure is as follows:

Warning

MURIATIC ACID USED IN THE FOLLOWING PROCEDURE IS HAZARDOUS. USE EYE AND SKIN PROTECTION WHEN HANDLING OR MIXING. KEEP AN EXTRA BOX OF BAKING SODA HANDY FOR FIRST AID OR TO NEUTRALIZE SPILLS. PERFORM THE PROCEDURES OUTDOORS IF POSSIBLE. IF THE WORK MUST BE DONE INDOORS, WORK ONLY IN WELL VENTILATED AREA.

Warning

IN THE FOLLOWING MIXING PROCEDURE, ALWAYS PUT WATER IN THE CONTAINER FIRST AND THEN ADD ACID TO THE WATER. ADDING WATER TO A CONTAINER OF ACID MAY RESULT IN A VIOLENT & DANGEROUS REACTION.

1. Prepare three plastic 5 gallon buckets as follows:
   A. Bucket #1 - Water
   B. Bucket #2 - One quart muriatic acid in four gallons of water (See Warnings Above)
   C. Bucket #3 - One pound baking soda in five gallons of water
2. After soldering is finished, dip the end of the line in the water to cool.
3. Set the cooled end of the line into the acid-water mixture for 5-10 minutes. This will loosen the film and brighten the silver.
4. Immerse the end of the line into the soda solution. This will stop the action of the acid.
5. Use a Scotch Bright pad or steel wool to scrub off the remaining torch black.
6. If the flux scale is particularly stubborn repeat the process.
7. When finished, rinse thoroughly when done with water and dry the line before assembling.

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a.5.1 Alternate Cleaning Method

The following is an alternate procedure to clean the soldered transmission line. The following materials are needed.

- Water and Hose
- Small Paint Brush
- Rubber Gloves
- Scotch Brite Pad or BBQ Grill Cleaning Pad With Handle
- Naval Jelly (or equivalent rust remover).

Warning

NAVAL JELLY CONTAINS PHOSPHORIC ACID AND CAN BE DANGEROUS IF IT COMES IN CONTACT WITH SKIN OR EYES OR IF IT IS SWALLOWED. READ AND FOLLOW THE PRECAUTIONS AND EMERGENCY PROCEDURES ON THE NAVAL JELLY CONTAINER BEFORE USING.

1. After soldering the flange, dip the end of the line into water or spray it with a hose until it is cool.
2. Using a small paint brush, apply a coating of Naval Jelly to the torch black and flux scale on the outside and inside of the line. Let the Naval Jelly set from 10 to 20 minutes.
3. Scrub the line with Scotch Brite or the BBQ Grill pad to loosen the torch black and flux scale.
4. Flush with water until the Naval Jelly residue is gone.
5. Repeat the process until all the torch black and flux scale is removed.

The first application of the Naval Jelly will remove the torch black and some of the flux scale. Normally, if vigorous scrubbing is done, repeating the process a second time will completely clean the line.

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Appendix-b
Cooling System Help

b

b.1 Coolant and Water Recommendations

The cooling loop uses a 50% mixture by volume of deionized water and industrial grade ethylene or propylene glycol. The recommended glycol products are listed below.

Equivalent coolants from another manufacturer may be used as long as its inhibitors are similar. Also, information on the properties of the product must be obtained from the manufacturer in order to calculate the transmitter power output calorimetrically.

Caution

DO NOT USE AUTOMOTIVE GRADE ANTI-FREEZE AS A SUBSTITUTION FOR INDUSTRIAL GRADE GLYCOL. IT DOES NOT CONTAIN THE PROPER INHIBITORS FOR THIS APPLICATION AND WILL LEAD TO EVENTUAL DAMAGE OF THE SYSTEM.

Table b-1 Recommended Coolants

Description	Part Numbers
DOWTHERM SR-1: ethylene glycol-based concentrated solution, 55 gallon drum Ethylene Gasket Kit	051-1010-002 335-0304-000
DOWFROST HD: Inhibited propylene glycol-based heat transfer fluid, 100% solution, 55 gallon drum DOWFROST HD: Inhibited propylene glycol-based heat transfer fluid, 50/50 solution, 30 gallon drum DOWFROST HD: Inhibited propylene glycol-based heat transfer fluid, 50/50 solution, 5 gallon container DOWFROST HD: Inhibited propylene glycol-based heat transfer fluid, 100% solution, 5 gallon container Propylene Gasket Kit	051-1012-000 051-1012-001 051-1012-002 051-1012-003 335-0301-000

Caution

SINCE THE WATER USED TO MIX WITH THE GLYCOL WILL AFFECT THE CORROSIVITY OF THE MIXTURE, ***ONLY HIGH QUALITY DEMINERALIZED WATER THAT HAS BEEN DISTILLED, DEIONIZED OR REVERSE-OSMOSIS PROCESSED SHOULD BE USED.*** *THIS WATER MUST HAVE A CONDUCTIVITY OF NO MORE THAN 5 MICROSIEMENS (OR HAVE A RESISTANCE OF LESS THAN 200K OHMS).*

The quality of water mixed with glycol concentrate can impact system performance. Poor quality water can cause scale, sediment deposits, or sludge throughout the cooling which will reduce heat transfer efficiency. Poor quality water can also cause damage to the system by depleting the corrosion inhibitor and can lead to the creation of a number of corrosions including general and acidic attack corrosions.

Good quality processed water contains:

- Less than 50 ppm of calcium
- Less than 50 ppm of magnesium
- Less than 100 ppm (5 grains) of total hardness
- Less than 25 ppm of chloride
- Less than 25 ppm of sulfate

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b.2 Plumbing System Installation

b.2.1 Materials needed

- Mapp gas torch set
- Extra Mapp gas tanks
- Welders mask or goggles
- Tubing cutter for 2.5 inch tubing (a hacksaw may be used instead of the tubing cutter)
- Flux (Stay Clean Flux) or equivalent (Harris part number 086 0004 040; one 16 oz bottle provided with plumbing kit)
- Soft silver solder (96.5% tin; 3.5% silver) such as Aladdin #450 (Harris part number 086 0004 038) is needed. Three 1 lb rolls of 1/16 inch soft silver solder is supplied with plumbing kit. 1/8 inch silver solder (Harris part number 086-0004-047) is also available.
- Wire brush and rags
- Water hose
- Thread rod, angle iron or channel and hangers needed to support the plumbing
- Tubing cutter or a hack saw (always de-bur the line (remove any rough points or flared-in edges at the cut after cutting)

Warning

TEMPERATURE OF THE HEATED LINE IN THE FOLLOWING STEPS IS QUITE HIGH. PRECAUTIONS MUST BE TAKEN TO AVOID CONTACT WITH EXPOSED SKIN.

b.2.2 Pipe Sizing and Routing

If a typical system layout is not used, the typical plumbing layout should still be consulted for pipe size information and connection details and techniques at the amplifier cabinets, RF loads, pump module and outside heat exchanger. A custom plumbing installation must not unduly restrict flow rates or change the design of the cooling system. Locate the plumbing so that access to transmitter system components is not restricted.

Note

Pipes must be sized no smaller than shown on the typical plumbing layout drawing. Their routing should minimize turns and long runs.

If additional amplifier cabinets are to be added to the system in the future, consider these plans when sizing and laying out the cooling system. Doing so now may slightly increase the installation cost, but will greatly lower the cost of conversion later.

The plumbing lines must be type “M” hard drawn copper with soft silver soldered joints (96.5% Tin, 3.5% Silver; Aladdin #450 silver solder or equivalent). An adequate amount of soft silver solder (Harris part 086-0004-038) is supplied with the plumbing kit. Good silver brazed joints are acceptable but not required. A poorly done brazed joint is much harder to repair than a soft silver solder joint.

b.2.3 Standard Coolant Plumbing Practices

Good plumbing equipment installation practice is required to ensure system integrity. Appropriately measured, cut, deburred, supported and soldered copper pipe sections, facilitate mechanical integrity of the coolant transportation system. The “glue” that holds the system together is quality soldering.

This process includes the need to condition all surfaces to be soldered by thorough cleaning with emery cloth or a non-sudsing scouring pad, with an even application of flux, liquid flux being preferred. This applies to all common surfaces of plumbing fittings and straight pipe sections. Any improperly cleaned and poorly fluxed surfaces, either

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one or both, will not allow the solder to flow properly for continuous adherence of the solder to the two surfaces being soldered. After cleaning and fluxing, a continuous and evenly distributed application of heat without overheating will result in an evenly distributed flow of solder between the surfaces being soldered for a plumbed system that does not leak. Remember that solder flows from a colder surface to a hotter surface no matter the orientation of the surfaces being soldered.

Since considerable heat is necessary to make the solder flow, some torch black and flaking may develop inside the pipe. Before hanging the line, it is recommended that a hose and wire brush or rag be used to clean and flush the inside of the line where possible. It is also recommended to wash the flux off the final soldered joint to prevent future tarnishing.

Note

Keep in mind that an over application of solder can result in solder balls falling in to the associated piping with the possibility of water flow restriction and/or blockage. Also, an under application of solder can result in water leakage paths between the common surfaces of the fitting being soldered.

Propane or Mapp gas is the recommended fuel for soldering copper plumbing pieces. These gasses are available in small metallic bottles that mate directly to appropriate torches. Also, a “Turbo Torch” or equivalent with appropriately sized regulator and hose combination can be used with larger gas tanks (large cooking stove tank). If these gas sources are not available, use of acetylene gas with an acetylene only torch is acceptable. In any event, only skilled plumbing and soldering practitioners, knowledgeable of the specific soldering equipment being used, should perform the required work.

Note

A soldering combination of silver bearing solder, i.e. Harris (not Harris Broadcast) Stay-Brite R (086-0004-038), and “Stay Clean” liquid soldering and tinning flux (086-0004-040) or equivalent, is recommended. Also, pipe thread joints should be conditioned with Teflon tape (299-0018-000) and a thin film application of a smooth, non-hardening thread sealing, compound with integrated Teflon is recommended, i.e. Locktite #565, or “Gasoila” (690-0017-000), prior to mating any two threaded pieces together.

When connecting threaded plumbing fittings, use a layer of teflon tape and some pipe dope *on the male fittings*. Do not use pipe dope on the female fittings because it will bunch up on the inside surface of the plumbing and interfere with normal cooling system operation. It is difficult to remove excess pipe dope from inside the system.

A final comment about the installation process centers around the need for the discipline of personnel in and around the cooling system installation area. Under no circumstances should anyone, cooling system installer and/or workers in other disciplines and areas, walk on pipes and fittings that have or have not been positioned and soldered. Although probably convenient for passage between adjacent work areas, walking on already soldered pipe can and historically has led to premature loss of solder joint integrity, among other self evident undesirable integrity results.

Caution

IF FREEZING CONDITIONS EXIST DURING CHECKOUT AND FLUSHING PROCEDURES, FLUSHING PROCEDURE AND SUBSEQUENT FILL WITH FINAL GLYCOL/WATER MUST BE FINISHED BEFORE STILL WATER IS ALLOWED TO REMAIN IN HEAT EXCHANGER. IF PROCEDURE CANNOT BE FINISHED, CARE MUST BE TAKEN TO PREVENT WATER FROM FREEZING IN OUTSIDE COOLING SYSTEM EQUIPMENT. IF WATER REMAINS IN OUTSIDE EQUIPMENT LONG ENOUGH TO FREEZE, THE UNITS WILL BE DAMAGED. ***PUMP A MIXTURE OF GLYCOL/WATER INTO OUTSIDE EQUIPMENT TO PREVENT DAMAGE.***

b.3 Routine System Operation and Maintenance

a. As a general rule of thumb, the entire system including all cabinets should be inspected for leaks on a routine basis. And any indication of a potential leak noted and corrected. The transmitter cabinet is equipped to detect internal leaks. For the rest of the system plumbing; however small leaks could evade detection.

If a system leak, is detected around a plumbed solder joint, the coolant should be drained, the leak point resoldered, and the system refilled and tested.

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Repairs for a leak originating at a threaded joint may be initially attempted by tightening the affected joint without draining the system. If this tightening effort does not correct the problem, then the system must be drained, the problem area opened and replumbed as necessary, followed by a system refill and test.

b. Probably the single most important maintenance step: Inspect the bottom of the heat exchanger bi-monthly. Inspect the coil itself for any debris that may have become trapped on the coil face. This would block air flow and decrease cooling efficiency of the heat exchanger. Debris can be removed using a hose and pressurized water system. In dusty environments or areas where an abundance of vegetation is present this inspection will be required weekly

c. To achieve even usage time per unit and ascertain that back-up integrity exists, it is recommended that the pumps in the pump module are operated alternately one month at a time.

d. Check the pump module pressure gauge to ensure that a consistent stable pressure is indicated.

e. Inspect and clean the filtration loop.

f. Check flow rate.

g. Per the comment included in b.2.3 Standard Coolant Plumbing Practices section, mandate a continual discipline of NOT allowing plumbing pipe, fittings, etc., to be walked on.

h. The system must be analyzed for glycol concentration, annually. Analysis can be provided by the glycol manufacturer or via use of an analytical test kit supplied through the manufacturer.

i. See documentation for detailed maintenance instructions.

b.3.1 Reserve Coolant Supply

A sufficient reserve supply of coolant and corresponding deionized water should be kept on hand to refill the entire system in the event of a major leak.

b.3.2 Clean-Up Plan

A plan for containment and spill clean-up acceptable to local environmental regulations should be considered.

b.3.3 Operating Environment

Ambient air temperatures near the heat exchanger dry cooler should not rise above 45°C for typical installations.

b.3.4 Measuring Specific Gravity

Specific gravity can be measured with a conventional float hydrometer and jar or a MISCO DFR 200 (or equivalent) digital refractometer to verify the 50/50 mixture.

b.4 Heat Transfer Solutions

b.4.1 Ethylene Glycol

Commercial Grade "Dowtherm SR-1 Inhibited Ethylene Glycol-based Heat Transfer Fluid" is the recommended heat transfer fluid to be used for the liquid portion of the cooling system. SR-1 can be purchased from Harris in 55 Gallon lots using the following part number:

051-1010-002 - SR-1, 100% concentrate

Automotive grade antifreeze is not recommended due to the silicon additives which can cause incompatibility problems with pump seals and other components within a system.

Due to a tendency of the glycol to break down over time when mixed with chlorinated water, it is recommended that distilled water be used for the solution.

The life expectancy of a “SR-1” system can be as long as 10-15 years for a clean system installed and monitored per the recommended procedures.

Glycols are excellent penetrants. Systems tested with water and checked to be tight sometimes will leak when glycol solutions are then added. Recheck the system for leaks after installing the glycol mixture.

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Appendix-c
Grounding Considerations, Surge Protection C

c.1 Surge and Lightning Protection

A lightning storm can cause transients in excess of 2kV to appear on power or field signal lines. The duration of these transients varies from a few hundred nanoseconds to a few microseconds. Power distribution system transient protectors can efficiently protect the transmitter from transients of this magnitude. Transients are shunted to ground through the protection devices and do not appear on the output. To protect the transmitter from high transients on field cables, electronic surge protectors are recommended.

All lightning protection is defensive in nature, that is, reacting to a lightning strike that has already occurred; therefore, its effectiveness is limited. Nothing can provide total immunity from damage in the case of a direct lightning strike. However, surge protectors installed immediately after the main power disconnect switch in the power distribution panel will afford some protection from electrical surges induced in the power lines.

Surge protection devices are designed to operate and recover automatically. When operated within specifications, a surge protector does not require testing, adjustment, or replacement. All parts are permanently enclosed to provide maximum safety and flexibility of installation.

To assure the safety of equipment and personnel, primary power line transformers must be protected by lightning arrestors at the service entrance to the building. This will reduce the possibility that excessive voltage and current due to lightning will seek some low impedance path to ground such as the building metallic structure or an equipment cabinet. The most effective type of power line lightning protection is the one in which a spark gap is connected to each primary, secondary, and the case of the power line transformer. Each spark gap is then independently connected to earth ground. In cases where driven ground rods are used for building ground, the primary and secondary neutrals must be separated by a spark gap. If two separate ground rods are used, the rods must be at least 20 feet apart. All connections between lightning arrestors, line connections, and ground must be made as short and straight as possible, with no sharp bends.

c.2 System Grounding

Signals employed in transmitter control systems are on the order of a few microseconds in duration, which translates to frequencies in the megahertz region. They are therefore radio-frequency signals, and may be at levels less than 500 microvolts, making them susceptible to noise appearing on ground wires or adjacent wiring. Thus, all ground wiring must be low in impedance as well as low in resistance, without splices, and as direct as possible. Four basic grounds are required:

1. AC ground
2. DC ground
3. Earth ground
4. RF ground

c.2.1 Ground Wires

Ground wires should be at least as large as specified by the local electrical code. These leads must be low impedance direct runs, as short as possible without splices. In addition, ground conductors should be insulated to prevent intermittent or unwanted grounding points.

Connection to the earth ground connection must be made with copper clamps which have been chemically treated to resist corrosion. Care must be taken to prevent inadvertent grounding of system cabinets by any means other than the ground wire. Cabinets must be mounted on a support insulated from ground.

c.2.2 AC Ground

The suggested grounding method consists of two separately structured ground wires which are physically separated from each other but terminate at earth ground. The green ground wire from the AC power input must connect to the power panel and the ground straps of the equipment cabinets.

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The primary electrostatic shield of the isolation transformer, if used, connects to the AC neutral wire (white) so that in the event of a transformer primary fault, fault current is returned directly to the AC source rather than through a common ground system. The AC neutral is connected to earth ground at the service entry.

Use of separate grounds prevents cross-coupling of power and signal currents as a result of any impedance that may be common to the separate systems. It is especially important in low-level systems that noise-producing and noise-sensitive circuits be isolated from each other; separating the grounding paths is one step.

Noise Grounding Plate. Where excessive high-frequency noise on the AC ground is a problem, a metal plate having an area of at least 10 square feet embedded in concrete and connected to the AC ground will assist in noise suppression. The connection to AC ground should be shorter than 5 feet, as direct as possible, and without splices. Local wiring codes will dictate the minimum wire size to be used.

Peripheral Equipment Grounds. All peripherals are supplied with a separate grounding wire or strap. All branch circuit receptacles must permit connection to this ground. This service ground must be connected through the branch circuit to a common grounding electrode by the shortest and most direct path possible. This is a safety ground connection, not a neutral.

Often, circuit common in test equipment is connected to power ground and chassis. In these cases, isolated AC power must be provided from a separate isolation transformer to avoid a ground loop.

c.2.3 DC Ground

DC grounds in the transmitter are connected to a ground bus, which in turn is routed to a common cabinet ground and then connected to an earth ground. The use of separate ground busses is a suggested method of isolation used to prevent cross-coupling of signals. These ground buses are then routed to the cabinet ground and to earth ground.

c.2.4 Earth Ground

The transmitter must be connected to earth ground. The connection must have an impedance of 5 ohms or less. For example, a one-inch metal rod driven 20 feet into moist earth will have a resistance of approximately 20 ohms, and a large ground counterpoise buried in moist earth will exhibit a resistance on the order of 1 to 5 ohms.

The resistance of an electrode to ground is a function of soil resistivity, soil chemistry and moisture content. Typical resistivity of unprepared soil can vary from approximately 500 ohms to 50kohms per square centimeter.

The resistance of the earth ground should be periodically measured to ensure that the resistance remains within installation requirements.

c.2.5 RF Ground

Electrical and electronic equipment must be effectively grounded, and shielded to achieve reliable equipment operation. The facility ground system forms a direct path of low impedance of approximately 10 ohms between earth and various power and communications equipment. This effectively minimizes voltage differentials on the ground plane to below levels which will produce noise or interference to communication circuits.

The basic earth electrode subsystem consist of driven ground rods uniformly spaced around the facility, interconnected with 2 or 4 inch copper strap. The strap and rods should be placed approximately 40 inches (1 meter) outside the roof drip line of the structure, and the strap buried at least 20 inches (0.5 meters). The ground rods should be copper-clad steel, a minimum of eight feet (2.5 meters) in length and spaced apart not more than twice the rod length. Brazing or welding should be used for permanent connections between these items.

Where a resistance of 10 ohms cannot be obtained with the above configuration, alternate methods must be considered.

Ideally, the best building ground plane is an equipotential ground system. Such a plane exists in a building with a concrete floor if a ground grid, connected to the facility ground system at multiple points, is embedded in the floor.

The plane may be either a solid sheet or wire mesh. A mesh will act electrically as a solid sheet as long as the mesh openings are less than 1⁄8 wavelength at the highest frequencies of concern. When it is not feasible to install a fine mesh, copper-clad steel meshes and wires are available. Each crossover point must be brazed to ensure good electrical continuity. Equipotential planes for existing facilities may be installed at or near the ceiling above the equipment.

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Each individual piece of equipment must be bonded to its rack or cabinet, or have its case or chassis bonded to the nearest point of the equipotential plane. Racks and cabinets should also be grounded to the equipotential plane with a copper strap.

RF transmission line from the antenna must be grounded at the entry point to the building with 2 or 4 inch copper strap. Wire braid or fine-stranded wire must not be used.

All building main metallic structural members such as columns, wall frames, roof trusses, and other metal structures must be made electrically continuous and grounded to the facility ground system at multiple points. Rebar, cross over points, and vertical runs should also be made electrically continuous and grounded.

Conduit and power cable shields that enter the building must be bonded at each end to the facility ground system at each termination.

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Appendix-d
Lightning Protection Recommendation

d

d.1 Introduction

What can be done with a 2 million volt pulse pushing 220,000 amps of current into your transmitting plant? Like the 500 pound gorilla it does what ever it wants to. There is not much that can be done to protect against a major direct lightning strike. This is called a significant impulse lightning stroke. It usually lasts less than 100 microseconds and is most destructive to electronic equipment because it contains huge amounts of high frequency energy.

Here are some examples of this damage:

- Melted ball and horn gaps.
- Ground straps burned loose.
- H.V. rectifier stacks shorted.
- Massive arc marks in the output circuit of AM transmitters.
- Ball lightning traveling into building on outer conductor of transmission line.

Figure d-1 is a map of the United States that shows the number of lightning days expected in any year, with Colorado, New Mexico, and Florida leading the list.

Figure d-2 shows the incidents to tall structures. A triggered event is one that happens because the tower was present. Without the tower the strike would not have occurred.

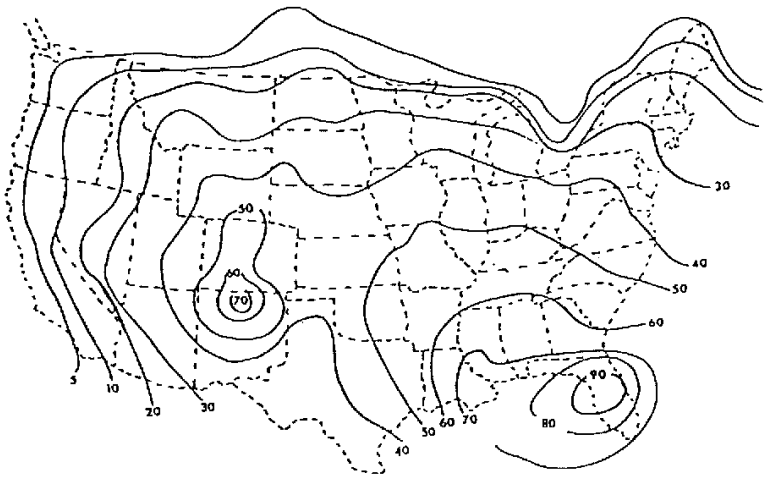

Figure d-1 Map Showing Lightning Days Per Year

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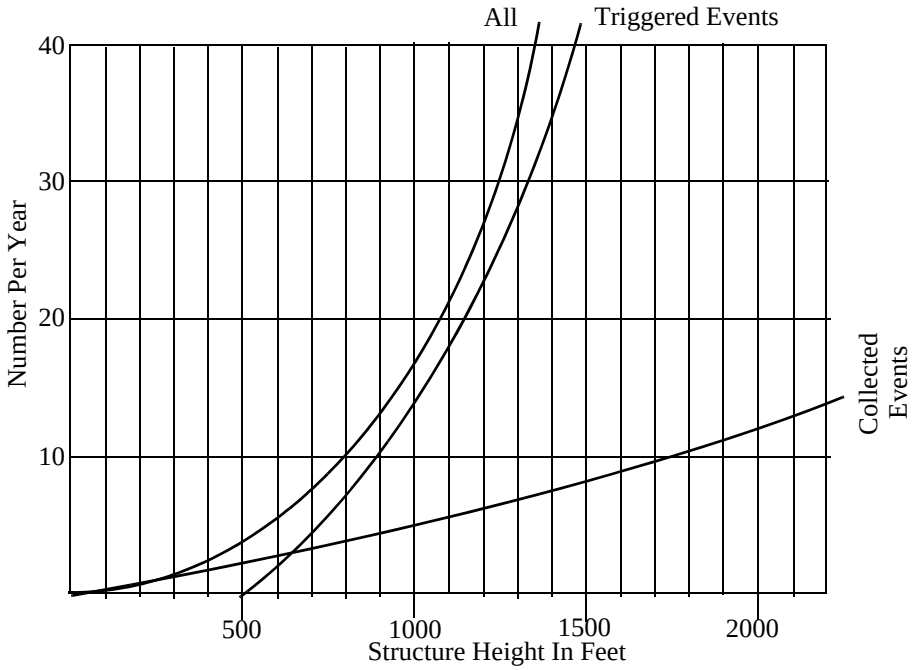

Figure d-2 Lightning Incidents to Tall Structures

d.2 Environmental Hazards

There are devices and procedures that do offer protection from lessor environmental hazards than lightning. Some of these anomalies are listed and defined:

1. Over voltage/under voltage (brownout). Where the lines voltage differs from the nominal RMS for longer than one cycle.
   Remedy - Automatic voltage regulators, preferably individual regulators on each phase. This can only be accomplished when the power feed line is delta or 4/wire wye connected, See Figure d-3.
2. Single phasing. This is where one leg of the three phase service is open.
   Remedy - Protection afforded by a loss of phase detector. Without protection power transformers and 3 phase motors over heat.
3. Radio frequency interference (RFI). This is something we must design into all transmitters, however, equipment may be purchased that is susceptible, is not protected, and may develop problems.
   Remedy - RFI filters on the ac lines and control lines are sometimes effective. Sometimes the entire device must be enclosed in an RF free space.
4. Electromagnetic pulse (EMP). This is a interfering signal pulse that enters the system by magnetic coupling (transformer). Generally caused by lightning.
   Lightning from cloud to cloud produces horizontally polarized waves while lightning from cloud to earth produce vertically polarized waves. The waves couple into the power lines and transmission lines causing large induced voltage that destroy high voltage rectifier stacks and output circuit faults. High frequency energy is coupled back into the transmitter causing VSWR overloads, See Figures d-4 and d-5.
   Remedy - Ball or horn gaps at the base of the antenna prevent the voltage from exceeding some high potential. Transient suppressor devices on the input power lines remove excessive voltage spikes. Buried power and transmission lines will reduce the amount of coupled ener-

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gy to a great extent. This does not totally eliminate the problem because there are currents traveling in the earth, which prefer to travel on the metal conductors, when lightning strikes close to the station.

5. Surge. A rapid increase in voltage on the power lines usually caused by lightning. The duration is less than 1/2 cycle and can be very destructive.
   Remedy - Transient protectors are very effective in preventing damage to the equipment when properly designed and installed, See Figure d-6.

Table d-1 Significant Lightning Stroke Characteristic

Charge Range	2 to 200 coulombs
Peak Currents	2,000 to 400,000 Amperes
Rise Time to 90%	300 Nanoseconds to 10 Microseconds
Duration to 50%	100 Microseconds to 10 Milliseconds
Potential Energy at 99%	1010 Joules*
* Only a small portion is manifested in a surge, usually less than 10,000 Joules.	

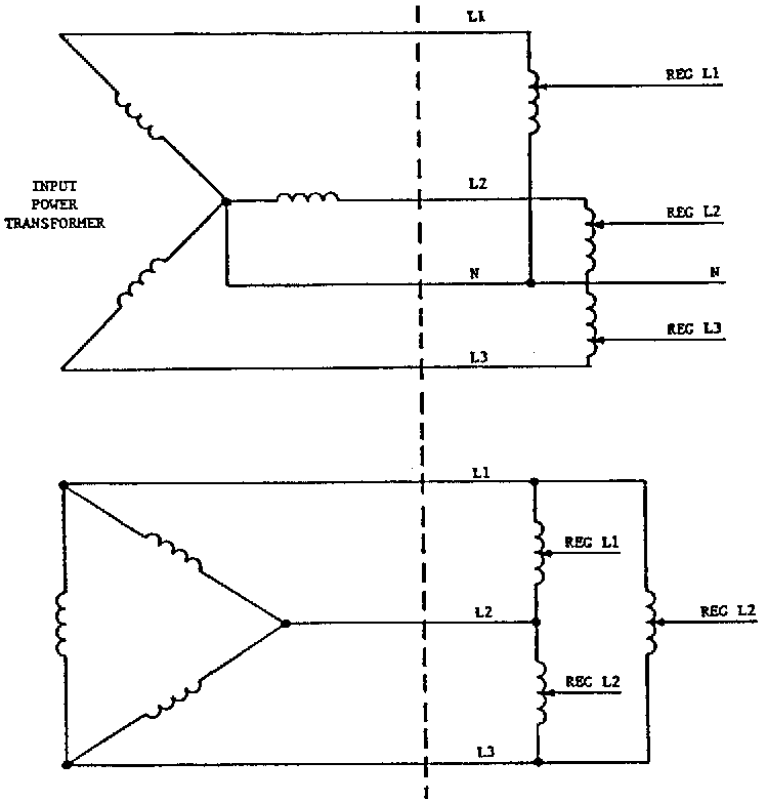

Figure d-3 Regulators for Delta and 4-Wire WYE systems

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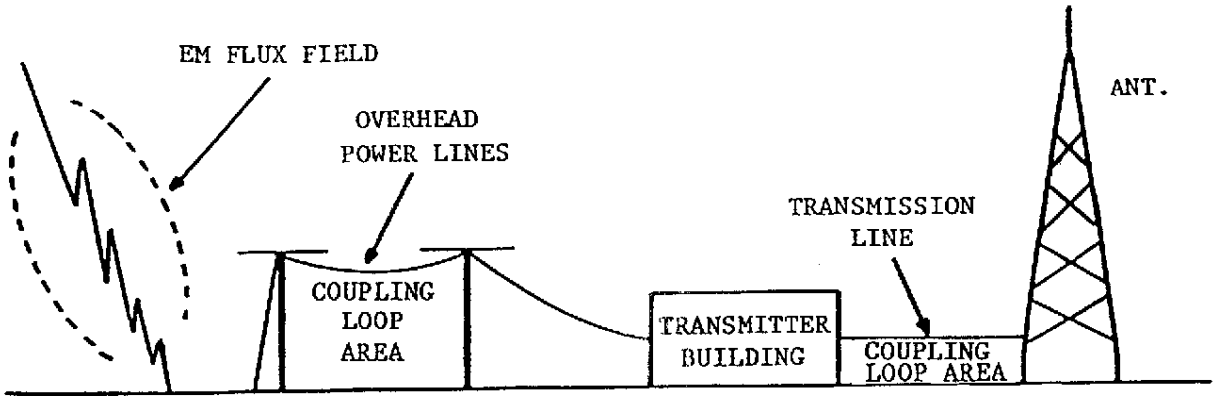
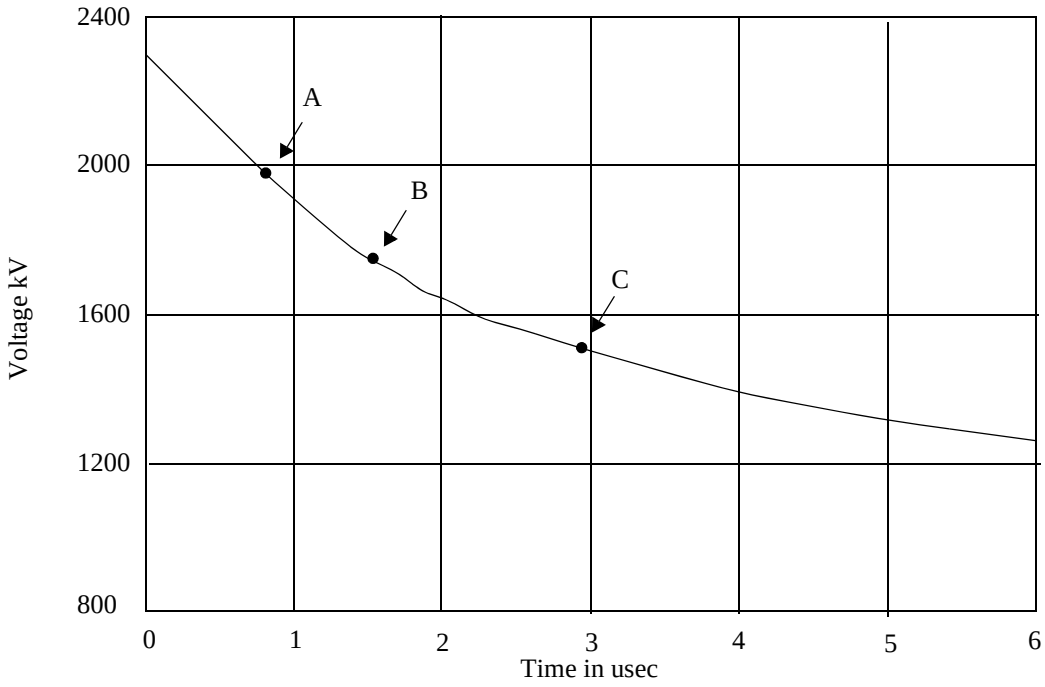


Figure d-4 EM Flux Field



A = 1/2 mile from station
B = 1 mile from station
C = 2 miles from station.

Figure d-5 Sample Surge Voltage as a Function of Distance From Stroke to Line

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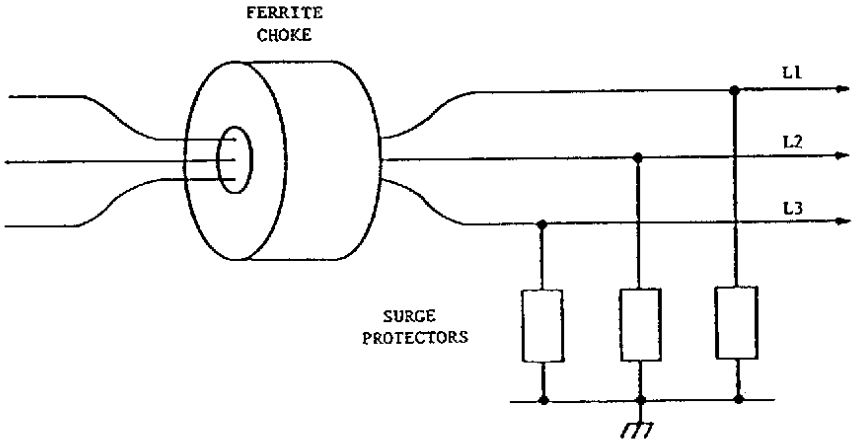

Figure d-6 Surge Protectors and Ferrite Chokes

d.3 What Can Be Done?

Installation of the transmitter building, antenna tuning unit if applicable, and antenna should be done so that the risk of destruction due to lightning is minimal and the efficiency of the over all system is maximized. To do this, separate ground systems should be installed for the building and antenna. This forces all of the RF return currents to flow in the transmission line shield. The coax can be buried below the antenna ground plane to still further reduce the RF current coupled to it.

In medium and short wave installations the antenna ground plane is very important as it is of the radiating element. RF current leaving the antenna must return via the ground path (ground wave). For this reason the “antenna coupling unit” must be close to the base of the tower and securely connected to the ground plane.

Figure d-7 shows the basic elements of a properly designed antenna system.

- Good ground plane.
- Ball gap on tower.
- Series inductor in tower feeder.
- Antenna coupling unit connected to antenna ground.
- The π circuit is equivalent to the normal Tee used by Harris.
- Underground coax.
- Guy wire length broken by insulators and grounded at the bottom end.

The transmitter building must be given extra protection to insure reliable equipment operation. A low impedance safety ground system must be installed using 3 inch wide copper strap hard soldered at all joints and connected to multiple ground rods located at the perimeter of the building. The ground rods should be wet to make good connection to the earth water table. All equipment cabinets within the building must be connected to the ground straps for safety reasons.

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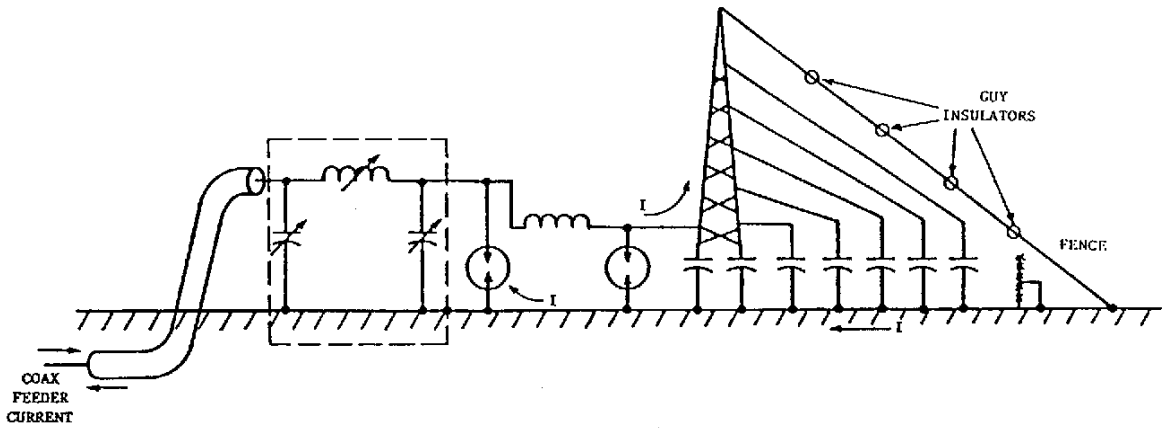

Figure d-7 Basic Elements of a Properly Designed Antenna System

d.4 AC Service Protection

All incoming ac lines should have a choke connected in series to limit the high frequency surges on the lines followed by a surge protector. The surge protector must be connected to the building ground system by short direct connections, see Figure d-6.

A surge protector is a solid state device that has a high impedance until the voltage across it reaches its rated clamping voltage, at which time its impedance suddenly decreases. The protector will then conduct hundreds to thousands of amperes to ground. All protectors are rated for maximum voltage and maximum surge energy. If the surge energy exceeds rating of the device it will normally short and for this reason must be fused so it will disconnect itself from the line being protected. When this happens all protection is lost so some warning system must be used to tell the operators that a new protector should be installed.

Speed is essential to protect equipment from current surges with rates of rise exceeding 10,000 amps per microsecond and pulses that last no longer than 100 microseconds. Very short, low inductance ground straps are required to pass surges of this type.

The surge protectors must be selected for the line to ground voltage and the maximum energy to be diverted. Bigger is always better in this case. There are several manufacturers of surge protectors:

- Lightning Elimination Associates., Inc.
- Current Technology
- Control Concept
- MCG Electronics, Inc.
- EFI Corp.
- General Electric

All of these vendors provide parts and systems to protect broadcast transmitters.

All audio and control lines should be protected the same as described for ac lines with components sized accordingly.

All coaxial lines should have the shield connected to the system ground at the point of entrance and in addition have a ferrite choke around it located between the entrance point and the equipment rack. This will provide a high impedance for current flowing in the shield but does not affect the signal currents.

d.5 Conclusion

The 1% chance of a major lightning strike probably can not be protected against but the other 99% can be controlled and damage prevented. Install surge protection on all incoming and outgoing lines at the wall of the building connected to a well designed ground system. Properly install the antenna ground system with spark gap adjusted correctly and maintained. With this done you can sleep peacefully at night if your bed isn't under the feed line.

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